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TOBACCO PRODUCTION RECOMMENDATIONS

Ministry of Agriculture and Food
ONTARIO
Jack Riddell, Minister
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PRECAUTIONS WITH PESTICIDES
INSECT CONTROL
DISEASE CONTROL
SUCKER CONTROL
FERTILIZATION AND SOIL MANAGEMENT
CULTURAL PRACTICES

86-05279/

Pesticide products listed in this publication have been reviewed by the Ontario Pesticide Advisory Committee and have been classified under the Pesticides Act.

To the best of the collective knowledge of the members of the Ontario Crop Protection Committee, the pesticides and their recommendations contained in this edition of *Tobacco Production Recommendations* were in effect as of November 12, 1985.

The recommendations in this publication are for the 1986 season and may be revised whenever further information is available. **Discard old editions.**

All recommendations in this publication are stated in metric units. Amounts of materials recommended for field application are for one hectare (ha) while greenhouse treatments are expressed in amounts per 100 square metres (100 m^2). Refer to pages 33 to 35 for conversion factors and metric equivalents.

POLICY STATEMENT

In this publication most recommendations list several pesticides that are effective for each insect or disease discussed. Where possible, the less hazardous materials and those that growers have used satisfactorily for a number of years are listed first. These are followed by the toxic pesticides and/or newer ones with which we have less experience. It must be emphasized that in some cases the most effective pesticides are highly toxic.

The effectiveness of pesticides, and plant injury by control chemicals, are influenced by the weather and other conditions. Consult the package label and other information regarding compatibility with other materials, the effect of high or low temperatures, poor drying conditions, etc. Wettable or soluable powder (WP and SP) preparations generally are less likely to cause plant injury than liquid concentrate (EC, SC, and F) formulations.

Assistance with problems regarding tobacco production may be obtained by contacting:

(a) Burley Tobacco
Clem Fisher, Research Station, Harrow, N0R 1G0 (519) 738-2251

(b) Flue-Cured Tobacco
Norm Sheidow or Milt Watson, Research Station, Delhi, N4B 2W9 (519) 582-1950

Agri-Phone—(519) 582-1713

The Ontario Ministry of Agriculture and Food maintains an Agri-phone at the Research Station, Delhi. Agri-phone messages, updated three times a week, are available throughout the growing season.

**TEMPORARY REGISTRATION OF PESTICIDES

Temporary registration of a pesticide is a procedure which is frequently used prior to full registration. Temporary registration is only granted for a period of one calendar year. On December 31 of each year, temporary registration status ceases. After that time period the pesticide may be discontinued, have the temporary registration extended or be granted full registration.

As of the printing date of this publication, the pesticides indicated with (**) were registered on a temporary basis for use in 1985. The fate of these materials has not been fully determined for 1986. Growers are urged to check the registration status of these pesticides prior to use. If a pesticide is no longer registered it is no longer legal to use it. A pesticide should not be used on any crop unless it has been registered for that crop.

Pesticides with a temporary registration and listed in this publication in 1985 include: Decis 2.5 EC, Lorsban 4 E, Orthene 75% SP, Ripcord 400 EC, Thuricide HPC, Basamid Granular, Ridomil 240 EC.

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PRECAUTIONS WITH ALL PESTICIDES

1. Always read the label before opening pesticide containers, and follow all precautions and directions.
2. Never smoke, chew tobacco or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.
3. Always wear neoprene gloves to handle the concentrate, and when coming in contact with dilute spray i.e. cleaning nozzles, and pumps, and handling contaminated spray equipment.
4. Inhalation of spray droplets, dust or fumes should be avoided. Wear a respirator to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. For gases a self-contained breathing apparatus may be required.
5. Wear freshly laundered clothes each day, including caps. Regularly wash gloves and boots. Avoid spilling pesticides on skin or clothing.
6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing spray equipment. Never fill a sprayer directly from a stream, pond or well unless the unit is equipped with an anti-backflow device to prevent siphoning.
7. Keep a record of the common names of all pesticides handled and especially those listed as hazardous in this publication. This list should be known by members of your family in the event of an accident.

IF ACCIDENTS OCCUR

1. If an accident occurs, remove contaminated clothing including under clothes immediately, and wash contaminated skin thoroughly with soap and water. Wash all clothing including caps, gloves and boots before reuse.
2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove all contaminated clothes including under clothes, have a bath or shower and put on freshly laundered clothing.
3. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. Take the list of common name chemicals with you to the hospital (see Emergency Procedures for Pesticide Poisoning).
4. Clean up any pesticide spills immediately. Use dry soil or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the pesticide Control Service for advice.
(See list page 32)

FIRST-AID INFORMATION

The Occupational Health and Safety Division, Ministry of Labour, 400 University Avenue, Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted:
Between 8:00 a.m. and 5:00 p.m. Monday to Friday. Telephone (416) 965-3610.
During weekends, public holidays and non-office hours, telephone (416) 965-1211 and ask for the "on-call" physician.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a pesticide is spilled on clothing or parts of the body, remove clothing including undergarments and wash skin and hair with water or soap and water if available. Flush eyes with plenty of water.

Should a person exhibit symptoms of poisoning such as weakness, slow heartbeat, incoordination, tremors, abdominal cramps, salivation, or blurred vision but is still conscious, seek medical help immediately by rushing the patient to the emergency ward of the nearest hospital. If the patient is unconscious call an ambulance.

Always know the common name of the chemical being used. Get this from the label or from your list mentioned above or use this book for reference.

RELATIVE HAZARDS TO HUMANS FROM PESTICIDES RECOMMENDED ON TOBACCO

Extreme Hazards—Guthion (azinphos-methyl); Phosdrin (mevinphos); Lannate (methomyl); Vorlex (DCP); Vorlex Plus (DCP); Vorlex CP (DCP + chloropicrin); Vorlex Plus CP (DCP + chloropicrin); Telone II (DCP); Telone C-17 (DCP + chloropicrin).

These pesticides are dangerous if inhaled, swallowed, or allowed to contact skin. A few grams can be fatal. Wear protective clothing (page 3), avoid mixing in windy areas, dispose of containers properly (page 5), and always change clothing and wash immediately after use.

Moderate Hazards—Basudin (diazinon); Diazinon; lindane; Lorsban (chlorpyrifos); Pirimor (pirimicarb); Ripcord (cypermethrin); Decis (deltamethrin).

These pesticides are dangerous if handled carelessly. Caution is required to insure that they are not taken internally or allowed to contact skin. Wear protective clothing including respirator and goggles when mixing or working with them. Avoid breathing the vapors. Remove clothing and wash after applying these pesticides. Triple rinse and dispose of containers properly (page 5).

Low Hazards—

Pesticides listed in this calendar and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely, if used properly, by following all directions and precautions listed on the label.

BLOOD TESTS FOR THOSE APPLYING PESTICIDES

Organophosphorus and carbamate pesticides are capable of inactivating the serum and the red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms.

For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the test should be commenced prior to using these pesticides and not after applications have commenced, since the normal level per individual can vary considerably, making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are those listed as extremely, highly and moderately hazardous under *Relative Hazards to Humans.*

PROTECTIVE CLOTHING WHEN WORKING WITH PESTICIDES

1. When measuring and mixing pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields. These protective materials may be penetrated by fumigants containing dichloropropene but polyethylene provides a good barrier to this material. When handling or applying fumigants containing dichloropropene shoes and hands should be covered with polyethylene.
2. Disposable gloves, aprons, overalls and hat covers are available at reasonable prices from the major safety supply companies.
3. Wash all clothing after use. Wear freshly laundered clothes each day.

RESPIRATORY PROTECTION WHEN USING PESTICIDES OUTDOORS

Although recommended when loading and handling concentrates, the wearing of dual cartridge chemical respirators is neither mandatory nor required with all pesticides or under all conditions of pesticide use. If a label specifies respiratory protection, follow the directions closely. A wide range of respiratory devices for outdoor respiratory protection from certain pesticides is available from the major safety supply companies who offer both full and half-face models in varying sizes. Consult the safety supply company of your choice for appropriate guidance and selection.

RESPIRATORY PROTECTION WHEN USING PESTICIDES IN GREENHOUSES AND OTHER ENCLOSED AREAS

Available Devices

Air-Purifying Devices—Canister Gas Masks

Canister gas masks have been used effectively for many years by greenhouse applicators for respiratory protection against certain gases, vapors and particulate matter which otherwise might be harmful to life or health.

From a practical standpoint, canister gas masks are generally suitable for ventilated areas not subject to rapid change, but should never be used in confined spaces where oxygen deficiency and high gas concentrations may occur.

Self-Contained Breathing Apparatus

Self-contained breathing apparatus approved by NIOSH (U.S. National Institute of Occupational Safety and Health) is the only apparatus recommended for respiratory protection in enclosed places where oxygen-deficiency with high gas concentrations occur.

Consult the Safety Supply Company of your Choice for Additional Information and Proper Selection. (See Table Below).

Working Conditions

High Concentrations

(a) Use only a self-contained breathing apparatus e.g. Scott, Air Pack.

(b) High concentrations of toxic gases, vapors or particulate matter can be produced when dispensing extremely or highly toxic pesticides such as parathion, nicotine and naled (Dibrom):

(i)through fogging machines
(ii)by means of smoke bombs
(iii)as spray applications.

In such instances self-contained breathing apparatus is recommended.

Low Concentrations

Canister gas masks may be used when the ambient air contains low concentrations of toxic gases, vapors, or particulate matter derived from soil drench, granular dust, or foliar spray applications. Pesticides applied in such manner are usually of moderate to low toxicity. The exceptions include aldicarb (Temik 10G) and fensulfothion (Dasanit 15G) but the wearing of canister gas masks provides protection.

TABLE 1. SAFETY SUPPLY COMPANIES IN ONTARIO PROVIDING PROTECTIVE CLOTHING AND/OR RESPIRATORY DEVICES FOR PROTECTION AGAINST CERTAIN PESTICIDES

Respiratory Devices Manufactured By	Available From
American Optical	AOCO Limited, Subsidiary of American Optical Corporation, 60 Mobile Drive, Toronto, M4A 2R7. Tel. (416)752-8780 Branches: Hamilton & Belleville.
H.S. Cover (York)	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3S9, Tel. (416)425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Kasco Helmets	The St. George Co., St. George, N0E 1N0. Tel. (519)442-2046
Mine Safety Appliances	MSA Canada Inc., 148 Norfinch Drive, North York, M3N 1X8. Tel. (416)667-9400
3M Occupational Health & Safety Products Div.	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8. Tel. (416)364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
North	Siebe-North Inc., 26 Dansk Court, Rexdale, M9W 5V8. Tel. (416)675-2790
Racal Airstream	Safety Supply Canada, 214 King St. East, Toronto, M5A 1J8. Tel. (416)364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
Safety House	Safety House of Canada Ltd., 1275 Castlefield Ave., Toronto, M6B 1G4. Tel. (416)789-0631 Branches: Kitchener, London, Orillia, Ottawa, St. Catharines & Stoney Creek.
Scott	Safety Supply Canada, 214 King Street East, Toronto, M5A 1J8. Tel. (416)364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Scarborough, South Porcupine, Thunder Bay and Windsor.
Survivair	Levitt-Safety Ltd., 33 Laird Drive, Toronto, M4G 3G9. Tel. (416)425-8700 Branches: Kitchener, London, Ottawa, St. Catharines, Sarnia, Stoney Creek, Sudbury and Thunder Bay.
Willson	Safety Supply Canada, 214 King Street East, Toronto, M5A 1J8. Tel (416)364-3234 Branches: Hamilton, Kingston, Kitchener, London, Mississauga, St. Catharines, Sarnia, Sarborough, South Porcupine, Thunder Bay and Windsor.

Many of the companies listed above have dealer outlets in addition to branch outlets. For details of dealer outlets contact the supply company of your choice.

RE-ENTRY TO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g., parathion, the label carries a warning regarding working in treated crops. Follow these recommendations. Where no label warnings are provided, minimum intervals recommended for re-entry are 24 hours for methomyl (Lannate) and 48 hours for mevinphos (Phosdrin), azinphosmethyl (Guthion) and oxydemeton-methyl (Metasystox-R).

STORAGE

1. **General Storage**
   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals.

   Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage
   Schedule 1, 2 and 5—pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING—AUTHORIZED PERSONNEL ONLY" in block capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers. See also OMAF Factsheet, *Farm Storage of Pesticides,* Agdex 607.

3. Post pesticide storage areas with proper notices.

4. In areas where flooding has been a frequent occurrence, fertilizers and pesticides must be stored above the known high water mark to avoid contamination of the flood waters. Contamination of water by these chemicals can and has led to serious health problems, affecting humans, domestic animals as well as fish and wildlife.

DISPOSAL OF PESTICIDE CONTAINERS AND CONTAMINATED MATERIAL

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or outdoor areas frequented by the public.

2. Un-rinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful—why not use that 3% for the purpose for which it was purchased, i.e., to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the container directly into the spray tank. This procedure takes less than a minute. The rinsed containers may be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

1. correct calibration and maintenance of spray equipment;
2. correct operation of the equipment;
3. the toxicity of the pesticide in use; and
4. the weather conditions.

For more information consult OMAF Factsheet *Pesticide Drift,* Agdex 607 or Canadex 607, *Pesticides: effects of drift and droplet size.*

APPLICATION BY AIRPLANE OR HELICOPTER

Aerial applicators must be licenced by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of the Pesticides Act for the application of Schedule 1 and 5 pesticides and Schedule 2 hormone-type herbicides. The area will be inspected by Ministry personnel to ensure safety of application.

It is an offence under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g., Seven (carbaryl).

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate application, in the contract.

PESTICIDE RESISTANCE

Many of the pesticides recommended have a very special mechanism of action, that is, they act on a single system or site in the organism. These materials should not be used continuously and repeatedly in a season-long program since this will increase the chances of the development of pest resistance. Examples of these types of compounds are Benlate, Lannate and the pyrethroids (Ambush, Ripcord, Decis and Pounce).

In our recommendations we suggest that such compounds be used in combination with other pesticides or that they be alternated with other pesticides so that the likelihood of resistance development is reduced.

ABBREVIATIONS

EC	= emulsifiable concentrate	kg	= kilogram
SC	= spray concentrate	g	= gram
WP	= wettable powder	ha	= hectare
SP	= soluble powder	m	= metre
F	= flowable	cm	= centimetre
G	= granules	mm	= millimetre
°C	= degrees Celsius	L	= litre
%	= percent (by weight)		

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seisure of the crop.

PESTICIDE RESIDUES

To minimize or eliminate pesticide residue in cured tobacco:

1. Observe the specified interval between foliar treatment and harvest as indicated in brackets following the recommendation.
2. Do not apply more than the recommended amount.
3. Do not apply more often than recommended on the label.

For example, Ambush 500 EC, 140 mL/ha (55 days) indicates that Ambush should not be used later than 55 days before the treated tobacco is harvested, and no more than 140 ml of the 500 EC formulation should be used for one hectare of crop in an application.

NOTE: Recommendations in this publication refer to both flue-cured and burley tobaccos unless otherwise indicated.

INSECT CONTROL

Observe the specified interval between foliar treatment and harvest as indicated in brackets following the recommendation.

CUTWORMS

(a) Greenhouse

When damage appears, spray the plants in the evening with one of the following per 100 m^2 of seedbed area in 15 L of water:

**Ripcord 400 EC—3 mL (about 1/2 teaspoonful)
Ambush 500 EC—2.5 mL (1/2 teaspoonful)
Dylox 80% SP—45 g
**Decis 2.5 EC—8 mL

Treatment with Ripcord and Ambush for cutworm control has been observed to provide some reduction of ants and grasshoppers.

(b) Field

Use one of the following three alternatives. Apply materials during late afternoon or in the evening using at least 220 L/ha of water. Cutworms may migrate to tobacco fields from bordering areas. Use Lorsban, Ambush, Ripcord, Decis or Pounce to treat these areas according to label directions and precautions.

(1) Cover Crop—
**Lorsban 4 E—1.2 L/ha
Ambush 500 EC—140 mL/ha
**Ripcord 400 EC—90 mL/ha
**Decis 2.5 EC—200 mL/ha
Pounce 384 EC—175 mL/ha

Treatment of the cover crop is most effective when applied soon after the cutworms have hatched. Application can usually be made in mid-to-late-April. When the cover crop is 10-15 cm high the cutworms will be at the right stage for best control. Treat 4 to 5 days before plowing.

(2) Soil—
**Lorsban 4E—2.4 to 4.8 L/ha
Ambush 500 EC—140 to 275 mL/ha
**Ripcord 400 EC—175 to 350 mL/ha
**Decis 2.5 EC—400 to 800 mL/ha
Pounce 384 EC—175 to 350 mL/ha

These materials work best when the soil is moist. Use the higher rates when the top 2 cm or more of soil is dry. Treat 1 to 3 weeks before planting, and preferably before mid-May.

The soil should not be disturbed for at least 5 days after applying Ambush, Ripcord, Decis and Pounce since mixing with the soil will reduce the effectiveness of these materials.

Lorsban is perferably left on the soil surface although very shallow incorporation (2 to 3 cm) is not likely to reduce its effectiveness. However, deep incorporation may lower the activity of Lorsban.

**See temporary registration of pesticides inside front cover

(3) After Planting—
Ambush 500 EC—140 mL/ha (55 days)
**Ripcord 400 EC—175 mL/ha (60 days)
**Orthene 75% SP—1.50 kg/ha (3 days)
**Decis 2.5 EC—400 mL/ha (70 days)
Pounce 384 EC—175 mL/ha (55 days)

This treatment may also be used if pre-planting treatments fail to provide control. Treat when 5% or more of the young seedlings show signs of cutworm feeding.

NOTE 1. For cutworm control late in the season, i.e., during late June and July, use only Orthene because the treatment to harvest intervals established for Ambush (55 days), Ripcord (60 days), Decis (70 days) and Pounce (55 days) permit use of these materials only during a short period of time after planting.

2. Alternating the use of pyrethroids (Ambush, Ripcord, Decis and Pounce with Lorsban for pre-planting and Orthene for post-planting treatments is recommended as a means of reducing the risk of cutworms becoming resistant to these materials. See Pesticide Resistance, Page 5.

3. Insecticides for cutworm control after planting may be overall or band applied. Rates of application are per treated hectare. When band spraying, a treated hectare is not the same as a crop hectare. For example 1 treated hectare would be equivalent to 4 crop hectares when spraying a 25 cm band on a 1 m (100 cm) row spacing.

WIREWORMS

Use one of the following amounts of insecticide per 180 L of planting water:
Lindane 25% WP—28 g
Benesan 50% WP—14 g

Apply 170 mL of the mixture per plant. With 107 x 61 cm spacing, 2600 L/ha would be required.

Stir mixture frequently to reduce settling and drain the barrel occasionally to avoid overconcentration of the insecticide. Lindane may be used in combination with Basudin in the planting water.

SEED MAGGOTS

Well hardened, sturdy transplants are less apt to be retarded by maggot feeding. Use one of the following per 180 L of planting water:
Basudin 50 W or Diazinon 50W—42 g
Lorsban 25W—50 g

Apply 170 mL of the mixture per plant. With 107 x 61 cm spacing, 2600 L/ha would be required.

Stir the mixture frequently to reduce settling and drain barrel occasionally to prevent overconcentration of the insecticide. Basudin or Diazinon may be used with lindane in the planting water.

Caution

1. Do not combine Lorsban with Lindane or Benesan in the planting water.
2. Do not combine Basudin, Diazinon or Lorsban with starter fertilizer in the planting water.
3. Band treatments of granular fertilizer should be placed 10 cm on each side of the tobacco row. Closer placement, in combination with Basudin, Diazinon or Lorsban in planting water, may injure tobacco plants.
4. Avoid contact with planting water containing Lindane, Benesan, Basudin, Diazinon or Lorsban.

TARNISHED PLANT BUGS

Tarnished plant bugs occasionally infest tobacco fields during July. They feed on the leaves and injure the leaf midrib, causing the end of the leaf to wilt or break.

Use the following:
Dylox 80% SP—1.50 kg/ha (3 days)

HORNWORMS

Treatment is justified when the population averages 5 or more hornworms per 100 plants.

If the above population occurs, use one of the following in sufficient water to provide adequate coverage; repeat if necessary.

1. Dipel, 275 g/ha (0 days)
2. **Thuricide HPC, 1 to 1.5 L/ha (0 days). See note (2) below
3. **Orthene 75% SP, 725 g/ha (3 days)
4. Dylox 80% SP, 1.50 kg/ha (3 days)
5. Sevin 50% WP, 2.25 kg; 80% WP, 1.50 kg; 85% WP, 1.25 kg/ha (3 days)
6. Lannate Liquid, 2.25 L/ha (5 days). *Minimum period before entering fields treated with Lannate is 24 hours.*

Ground or aircraft applications are equally effective. Do not work in tobacco fields during application of chemical insecticides. Observe the recommended interval between treatment and harvest.

Tobacco treated with Thuricide HPC or Dipel can be handled immediately after treatment as these materials are not poisonous to man or animal.

NOTE (1)Hornworms stop eating immediately after feeding on tobacco treated with **Thuricide HPC or Dipel. The larvae may remain alive but not feeding up to 6 days after treatment.
(2)Use the higher rate of **Thuricide HPC when insect pressure is severe, or when large worms are present, or when the foliage is abnormally rank and dense.

**See temporary registration of pesticides inside front cover

APHIDS

Seedbeds

If aphids are present, use the following per 100 m^2 of bed at least 5 days before first plants are to be pulled; repeat if necessary.

Malathion 25% WP—30 g per 12 L of water applied at 12 to 24 L, depending on size of plants.

Field

Treat especially the undersides of the leaves with one of the following when at least 20% of the plants have 5 or more groups of aphids on each upper leaf:

1. Pirimor 50 W, 275 to 550 g/ha (14 days)
2. Metasystox-R, 1.25 L/ha (14 days) (flue-cured only). *Minimum period before entering fields treated with Metasystox-R is 48 hours.*
3. **Orthene 75% SP, 725 g/ha (3 days).
4. Lannate Liquid, 2.25 L/ha (5 days). *Minimum period before entering fields treated with Lannate is 24 hours.*
5. Guthion 240 SC, 3.50 L/ha or 50% WP, 1.7 kg/ha (6 days). *Minimum period before entering fields treated with Guthion is 48 hours.*
6. Malathion 50% EC, 2.00 L/ha (7 days).
7. Phosdrin 100% liquid, 150 mL/ha (3 days). *Minimum period before entering fields treated with Phosdrin is 24 hours.*

NOTE

1. Thorough spray coverage of the upper part of the plant, where aphids are normally found, is essential to obtaining good control. Follow label directions for nozzle arrangements and spray volumes.
2. Malathion is not effective at temperatures below 18°C.
3. Application of non-systemic insecticides by aircraft for aphid control may not be as effective as ground application because of inadequate underleaf coverage.

FLEA BEETLES

These small, shiny, black jumping beetles chew small holes in the lower leaves. If high populations are present, use one of the following:

Sevin 50% WP, 2.25 kg; 80% WP, 1.50 kg; 85% WP, 1.25 kg/ha (3 days)
**Orthene 75% SP, 725 g/ha (3 days)

NOTE

These insects seldom cause sufficient damage to warrant treatment.

WARNING

Avoid inhaling pesticide dust or spray.

**See temporary registration of pesticides inside front cover

DISEASE CONTROL

For additional information on diseases affecting tobacco refer to Agriculture Canada Publication 1641, *Tobacco Diseases* and Ontario Ministry of Agriculture and Food Factsheet *Blue Mold of Tobacco* Agdex No. 181/632—September, 1984.

SEEDBED STERILIZATION

Thorough sterilization is necessary to rid the seedbed of weeds, soilborne diseases and nematodes.

Steaming Steaming is considered to be the most consistent and reliable method of sterilization, provided the soil is in proper condition and sufficient time is taken to obtain the required temperature.

Steaming may be done in the fall or spring. Conditions in the fall are likely to be more favorable for thorough steaming than in the spring when frozen soil is often a problem. Fall steaming also has the advantage of allowing time for the recovery of soil micro-organisms, some of which may compete with damping-off fungi, reducing their spread and development. One disadvantage of steaming in the fall is the possible reinfestation of the seedbed with weedseeds and diseases due to glass breakage during the winter.

The usual method is to inject steam under a metal pan although large plastic sheets are being used in a few cases. To provide optimum conditions for steam penetration, the seedbed should be uniformly loose with just enough moisture for the germination of seeds.

For thorough sterilization with steam, a temperature of 82°C held for 30 minutes at a 15 cm depth is required. These requirements will normally be met by steaming under pans for half an hour. Three to five hours may be required when plastic is used, depending mainly on soil condition, type of steamer, and size of plastic. A soil thermometer should be used to determine the required steaming time.

Fumigation The chemicals Basamid, Mylone, Vorlex and Vapam may be used as alternatives to steaming. These materials must be applied in the fall preferably before the end of October. Late fall or spring application, is likely to result in damage to germinating tobacco seed and young seedlings.

Acceptable control of weeds, most fungi and nematodes is usually obtained with these chemicals. However, there has been some variation in effectiveness in controlling the fungus disease black root rot which can be a serious pro-

blem in the seedbed. Thorough steaming is the most reliable means of controlling black root rot.

Having the seedbed prepared and thoroughly moistened at least a week before treatment is essential in obtaining good results. Sufficient moisture for seed germination must be maintained in the seedbed during the 7 or more days before treatment. Excess moisture should be avoided during this period.

The following amounts of material are for 100 m^2 of seedbed area:

**Basamid—3.25 to 5 kg
Mylone—6.5 kg
Vorlex—6 L
Vapam—10 L in 800 L of water

Consult product labels for further information on the proper application of these materials.

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Treatment of Walls, Walks and Boards Disease organisms, harbored on walls, walks and boards, may contaminate the sterilized seedbed. A formaldehyde solution (1 L of formalin to 25 L of water) applied to these areas after steaming, and 4 to 5 days before seeding, has proven effective in reducing seedling diseases, particularly those causing damping-off. It is preferable to apply the solution on a warm day. After the solution has been applied, the greenhouse should be closed for 2 days and then opened for at least 2 days before seeding, to allow injurious fumes to escape.

Caution Avoid drenching areas of the seedbed with the formaldehyde solution. Damage to germination and seedling growth may occur where the seedbed is drenched with formaldehyde 4 to 5 days before seeding.

DAMPING-OFF (BED ROT)

Damping-off is caused by organisms (mainly Rhizoctonia and partly Pythium) present in most soils. It may affect very young seedlings just as they are emerging, causing the plants to shrivel and die. Later occurrence of the same disease may be indicated by a wet rot which develops where plant stems and leaves decay at the ground surface. The disease is often found in patches throughout the seedbed, and is usually most serious where there is a thick stand of plants. In most cases recontamination of the sterilized seedbed is the main cause of the disease. Conditions such as humid atmosphere, wet seedbed soil, and thick stands of seedlings, favor development of damping-off.

Control

The prevention or control of damping-off depends on a combination of good greenhouse management and the proper use of fungicides. Apply the following per 100 m^2 when damping-off first appears.

Benlate 50W at 125 g in 250 to 350 L of water. Repeat if necessary.

NOTE Benlate provides good control of the more common Rhizoctonia type of damping-off.

The following management procedures will help in the prevention and control of damping-off:

1. Before sterilizing, loosen the seedbed to promote good drainage.
2. Thoroughly sterilize the soil.
3. Surface sterilize shoes and tools before walking and working in a sterilized seedbed. Use a formaldehyde solution mixed 1 to 25, formalin to water.
4. Treat walls and walkways with a formaldehyde solution. (See **Seedbed Sterilization.**)
5. Use the recommended seeding rates.
6. After the plants cover the seedbed, do not water in the afternoon.
7. Ventilate as much as possible.
8. Aim to have the seedbed surface as dry as possible by evening.

BLACK ROOT ROT (Seedbed)

The disease is found where the soil has not been properly sterilized. Usually small areas of the seedbed are affected. Diseased plants transplanted to the field will be very slow to start growing.

Control

Thorough sterilization will control this disease in the seedbed. Avoid deep working of the seedbed after sterilization.

YELLOW PATCH

Characterisitic symptoms of yellow patch are irregular patches of yellow, stunted plants in the seedbed. Roots of affected seedlings exhibit various degrees of discoloration and rotting. In severe cases affected seedlings die; in milder cases new rootlets develop above the rotted ones and the plants may recover.

Control

This trouble is caused mainly by excessive fertilization of the bed before sowing and can usually be prevented by following the fertilizer recommendations. If yellow patch develops, some relief can be obtained by allowing the soil to dry out thoroughly for about 2 days and then watering heavily to leach out some of the excess fertilizer. (See page 15, under **Seedbed Fertilization.**) Excessive compaction of the seedbed soil tends to aggravate this condition.

2,4-D INJURY

Symptoms vary depending on the amount of 2,4-D to which the plants are exposed. Usually the most obvious symptom is extreme leaf distortion. Affected leaves droop, are narrow and often more or less strap-shaped with very prominent veins and wavy or deeply-toothed margins and, in many cases, the surface is blistered. In mild cases the plants may recover, but in severe instances there is no recovery from the damage.

Control

Tobaco plants are very sensitive even to small amounts of 2,4-D. Any sprayer or other equipment that has been used for 2,4-D application should **never** be used on tobacco. Spraying with 2,4-D should not be done near tobacco beds or tobacco fields because there is always danger of spray or vapor drifting.

ATRAZINE DAMAGE

When this material is present in the seedbed, at or soon after seeding, plants will emerge but they soon dry up and disappear. When applied to larger plants in the seedbed, atrazine causes a yellowing of the leaves, especially the tips and margins and, depending on amount, death of the leaf or entire plant may occur.

Symptoms of Bladex and other triazine herbicides are similar to atrazine.

Control

Sprayers or parts of spray equipment that have been used to apply atrazine or other triazine herbicides should never be used to spray tobacco. Be careful not to contaminate water supplies and never fill the herbicide sprayer near the greenhouse.

BLUE MOLD

(a) **Seedbed** On small seedlings the first leaves lose their normal green color and a grey to bluish mold develops. Larger seedlings show a more pronounced yellowing and often wilt slightly. Affected seedlings are unsuitable for transplanting as they remain stunted and the brittle stems are easily broken by wind.

(b) **Field** Infected leaves initially show large yellow spots with greyish-blue mold on the undersurfaces. As these spots age they become brown and the dead tissue eventually drops out either in the field or during curing.

Control

(a) Seedbed—Steam sterilization of the seedbed and treatment of the walls and walkways with a formaldehyde solution as described under Seedbed Sterilization are recommended to destroy any blue mold contamination in the greenhouse.

Apply **Ridomil 240 EC at 50 mL in 100 L of water per 100 m^2 of seedbed within a period of 3 days before seeding.

(b) Field—Registered preventive measures as approved by the Blue Mold Task Force will be recommended according to label directions.

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FIELD STUNTING OF TOBACCO

Root lesion nematodes and black root rot are the main causes of stunting in Ontario. Occasionally a combination of both diseases may occur or a third factor, as yet undefined, may be involved.

Nematodes Nematodes are most likely to occur in sufficiently high populations to cause stunting on the well-drained medium to light tobacco soils. The main characteristic of nematode damage in the field is the appearance, in late June or early July, of patches of stunted plants which tend to wilt, particularly during mid-day. Root systems are usually quite small and brown areas may be seen on the roots. In severe cases, the plants remain stunted throughout the season, and the yield will be greatly reduced. In milder cases, the affected plants may recover by mid-summer, but such plants are late in maturing.

Black Root Rot This disease is more prevalent on the heavy or poorly-drained tobacco soils, and during cool wet seasons. Damage is usually more severe where there is a crop sequence of tobacco following tobacco. Under severe conditions, plants are stunted early in the season, and their maturity is delayed, resulting in a reduction of yield and quality of tobacco. Crop losses are seldom high where varieties with high tolerance to black root rot are used.

A satisfactory crop rotation such as rye-tobacco or wheat-tobacco should br practiced to help prevent the buildup of black root rot in the soil. For flue-cured tobacco on heavy or poorly-drained soils, a corn-tobacco rotation may prove beneficial in reducing black root rot. Varieties are now available which have a high degree of tolerance to this disease. Of the flue-cured tobacco varieties, Delhi 76, Nordel and Delgold are the most tolerant, followed by Virginia 115, Candel and Newdel (pages 26 and 27). The burley varieties, Burley 1 and Harwin, have shown tolerance to the disease.

Control

Several soil fumigants are available to control nematodes and aid in reducing damage from black root rot. These materials must be injected into the soil about 15 cm deep in the spring about 3 weeks before planting.

(a) Nematodes

Where nematodes are considered to be the main problem use one of the following:

TABLE 2.

	Row		Broadcast
	L/ha (107 cm rows)	*mL/100 m of row	L/ha
Telone II	75 - 90	803 - 963	150 - 180
Vorlex	28 - 40	300 - 428	56 - 80
Vapam	65 - 85	696 - 910	170
Vorlex Plus	28 - 40	300 - 428	56 - 80

**mL/100 m of row remain the same regardless of row width*

NOTE Rates on the low side of the range for each material are considered the minimum required for nematode control.

(b) Black Root Rot

Where black root rot, or black root rot along with nematodes, is considered to be a problem, the following treatments will provide satisfactory nematode control and, at the higher rates, may help in reducing damage from black root rot.

Fumigants containing chloropicrin (Telone C-17, Vorlex CP and Vorlex Plus CP) are more effective than other fumigants in reducing black root rot.

TABLE 3.

	Row	
	L/ha (107 cm rows)	*mL/100 m of row
Telone C-17	75 - 100	803 - 1070
Vorlex CP	50 - 80	535 - 856
Vorlex	56 - 90	599 - 963
Vorlex Plus CP	50 - 80	535 - 856
Vorlex Plus	56 - 90	599 - 963

**mL/100 m of row remain the same regardless of row width*

NOTE Rate of fumigant application should vary within the recommended ranges according to the likely severity of black root rot considering contributing factors such as field history of previous black root rot, cropping sequence, type of soil and tolerance of variety to be grown.

Caution—Fumigant Damage Tobacco plants may be killed or severly stunted if the fumigant has not escaped from the soil before planting. The danger of toxic amounts of fumigant remaining in the soil is greatest in low, poorly-drained areas or in heavy tobacco soil. On these soils, injecting the fumigant to a shallow depth of 10 to 15 cm should help in reducing the risk of damage. Caution should be exercised with any tobacco soil, especially when high rates of fumigant are used and/or cool, wet conditions prevail during the period between fumigating and planting.

Fields should be checked in several places, about a week before transplanting, for odor of the fumigant in the soil near the point of injection. If fumigant odor is detected, where the field has been row fumigated, the hills should be opened, about one week before planting, with a single chisel or cultivator tooth. Re-opening may be necessary if heavy rainfall and cool temperatures occur after the initial opening. Where the fumigant has been broadcast, the soil should be cultivated to the depth of the treatment zone about one week before planting.

SORE SHIN

Each year sore shin affects some plants in fields of tobacco soon after transplanting. Affected plants show brown or black discolored areas on the stem near ground level. The extent of the lesion varies, sometimes being limited to one side or, in severe cases, completely girdling the stem. Some of the affected plants die soon after planting, while others may develop normally until later in the season when they may be broken off by wind.

Control

The disease has been noticed in the field under a wide range of moisture and temperature conditions. This may be attributed to the different strains of the fungus causing sore shin.

There is no chemical recommendation for the control of sore shin.

WEATHER FLECK

Weather fleck, a leaf disorder of flue-cured tobacco, is caused by certain oxidants in the air, mainly ozone. Oxidants damage the leaf tissue and cause the development of small spots that are irregular in shape and generally less than 4 mm in diameter. The spots are initially black, but later turn brown and eventually grayish white. The most serious losses generally occur just before or during the early part of harvest when the lower leaves are maturing.

Control

Present control measures involve cultural practices and varieties.

Certain cultural practices, such as proper spacing (page 28), proper irrigation, well-balanced fertilization, early topping and clean suckering, help to produce a leaf which is less susceptible to weather fleck. For tolerance of varieties, see pages 26 and 27.

FRENCHING

This disease occasionally appears, especially on marginal tobacco land. Severely affected plants are stunted and the leaves become thick and straplike. Sometimes only the suckers are affected.

Control

The tendency to french is definitely related to soil conditions. Improved drainage and good fertilization practices may help in avoiding the disease.

VIRUS DISEASES

(a) **Tobacco Mosaic** The tobacco mosaic virus appears to be quite variable; consequently, symptoms on affected plants may vary also. The characteristic symptom is leaf mottling with yellow-green and dark green areas. The younger leaves are frequently blistered and malformed. The major damage is reduced yield and quality.

Control

The following preventive measures should be taken:

1. Avoid smoking or using tobacco while working with seedlings in seedbeds or transplanting. Hands should be clean before handling seedlings.
2. Tobacco should not follow tobacco or tomatoes in rotation.
3. Transplanting and cultivating machinery used previously for tomatoes should be washed thoroughly.
4. Do not cultivate when plants are wet.
5. Rogue out diseased plants if they show virus symptoms within a few weeks after transplanting.
6. Certain weeds may become infected with mosaic, therefore proper weed control in greenhouses, fields and fencerows is important.

(b) **Tobacco Etch** This virus disease is established in much of the burley-growing acreage in the counties of Essex and Kent. Flue-cured tobacco is occasionally infected by etch. The virus overwinters in ground cherry, of which there are two common species occurring as weeds in fencerows, waste areas, and along roadsides. In June or early July, aphids transmit the virus from ground cherry to tobacco, pepper and tomato crops.

Control

Since late-planted tobacco is severly stunted by the virus, early planting is recommended. Also, tobacco should not be planted alongside weedy fencerows or near other waste areas. The variety Harwin is moderately resistant to etch. Good aphid control should reduce the severity of the disease.

(c) **Other Viruses** A number of other virus diseases may affect tobacco and cause severe damage. Symptoms may include severe leaf spotting, leaf mottling and death of leaf tissue. These viruses are transmitted by aphids.

Control

Tobacco fields should be checked every few days, particularly from late June until the first of August, for the presence of aphids. Apply one of the recommended insecticides (see page 8) at the first appearance of these insects.

POLE ROT

(a) **Flue-cured Tobacco** Pole rot caused by certain bacteria or fungi frequently develops during the yellowing stage of the flue-curing process.

Control

Curing trouble of this kind is most likely to occur when yellowing is prolonged or when excessively large tobacco or wet tobacco is crowded into the kiln. This reduces air circulation, and increases humidity.

In addition, when the outside air is hot and humid, it is more difficult to reduce humidity in the kiln.

When these conditions prevail, reducing the kiln load and ventilating earlier in the cure will help prevent the development of rot.

(b) **Burley Tobacco** Wet weather during curing often causes darkening or spoilage of burley leaf. This injury, commonly called barn burn, is caused by fungi and bacteria growing on the cured leaves when they become too moist. Burley tobacco cures best at 65 to 70% relative humidity. Barn burn may develop rapidly if the relative humidity in the barn exceeds 85 to 90% for more than 24 hours.

Control

To avoid excessive moisture in the barn, open the ventilators during the day when the weather is dry, and close them at night to keep out dampness. When wet weather threatens, close the barn.

Special heating equipment, which maintains the proper humidity for curing and prevents barn burn, is available.

The most common barn mold organism is botrytis sp. The fungus can survive from season to season on tobacco lathe. Washing or dipping lathe in a Chlorox solution (1 L Chlorox to 5 L of water) or a formaldehyde solution (1 L formalin to 20 L of water) for one to five minutes will eliminate the fungus on the lathe.

SUCKER CONTROL

The products listed in Table 4 may be applied before or after topping. Generally an application during the early to late bud stage is most satisfactory.

All of the products listed in Table 4 may be used on flue-cured tobacco. For burley tobacco, use only those products that include this tobacco type on the label.

Normally one application is sufficient. However, conditions such as an uneven crop or poor timing may reduce the effectiveness of the first application and in this case a second application 5 to 7 days after the first may be beneficial.

NOTE Directions for use vary somewhat from one product to another; therefore it is extremely important to read the label carefully and follow all directions and precautions. Conditions such as improper mixing, poor timing, boom pressures above 138 kPa (20 p.s.i.) and spraying during windy or excessively hot weather can result in crop damage. A lower rate of sucker control may be required on very tender tobacco.

CAUTION Use of higher than recommended rates of sucker control may cause "a deep burn" in the leaf axil. This may result in excessive and rapid sucker development from non-sucker tissue.

TABLE 4. LITRES OF SPRAY MIXTURE PER HECTARE

	Litres of Product		
	Before Topping	After Topping	Litres of Water
Chiptac	17	19	450
Delete	17	20	450
Emtrol	20	22	450
Emtrol Ten	17	20	450
Pfizol 10	17	20	450

PESTICIDE NAMES

i - insecticide
f - fungicide
n - nematicide
h - herbicide
s - sucker control

Common, Brand, and Trade Names		Examples of Brand Name Product, Common or other name of active ingredient
acephate	i	Orthene
Ambush *(3)	i	permethrin
azinphos-methyl	i	Guthion
Bacillus thuringiensis (3)	i	Dipel, Thuricide
Basamid (2)	ifnh	dazomet
Basudin (2)	i	diazinon
Benesan (2)	i	lindane
Benlate (3)	f	benomyl
benomyl	f	Benlate
carbaryl	i	Sevin
Chiptak (3)	s	fatty alcohol (n-decanol)
chloropicrin	if	Telone C17, Vorlex CP, Vorlex Plus CP
chlorpyrifos	i	Lorsban
cypermethrin	i	Ripcord
dazomet	ifnh	Basamid, Mylone
Decis (5)	i	deltamethrin
Delete (3)	s	fatty alcohol (n-decanol)
deltamethrin	i	Decis
diazinon	i	Diazinon
1,3-dichloropropene	n	Telone II, Telone C17
1,3-dichloropropene and other related cholorinated C_3 hydrocarbons	n	Vorlex, Vorlex Plus, Vorlex CP, Vorlex Plus CP
Dipel (3)	i	Bacillus thuringiensis
diphenamid	h	Enide
Dylox (3)	i	trichlorfon
Emtrol (3)	s	fatty alcohol (n-octanol and n-decanol)
Emtrol 10(3)	s	fatty alcohol (n-decanol)
Enide (3)	h	diphenamid
fatty alcohol (n-decanol)	s	Chiptac, Delete, Emtrol 10, Pfizol 10
fatty alcohol (n-octanol and n-decanol)	s	Emtrol
formaldehyde	f	formalin
formalin	f	formaldehyde
Guthion (5)	i	azinphos-methyl
Lannate (2)	i	methomyl
lindane	i	Benesan, lindane
Lorsban (2)	i	chlorpyrifos
malathion (3)	i	malathion
metalaxyl	f	Ridomil
metam-sodium	ifnh	Vapam
Metasystox-R (2)	i	oxydemeton-methyl

(Continued on Page 14)

PESTICIDES NAMES (Cont'd)

methomyl	i	Lannate
methyl isothiocyanate	fnh	Vorlex, Vorlex CP, Vorlex Plus, Vorlex Plus CP
mevinphos	i	Phosdrin
Mylone (2)	ifnh	dazomet
Orthene (2)	i	acephate
oxydemeton-methyl	i	Metasystox-R
pebulate	h	Tillam
permethrin	i	Ambush, Pounce
Pfizol 10 (3)	s	fatty alcohol (n-decanol)
Phosdrin (5)	i	mevinphos
pirimicarb	i	Pirimor
Pirimor (2)	i	pirimicarb
Pounce (3)	i	permethrin
Ridomil (2)	f	matalaxyl
Ripcord (2)	i	cypermethrin
Sevin (3)	i	carbaryl
Telone II (2)	n	1,3-dichloropropene
Telone C17 (2)	n	1,3-dichloropropene + chloropicrin
Thuricide (3)	i	Bacillus thuringiensis
Tillam (3)	h	pebulate
trichlorfon	i	Dylox
Vapam (3)	ifnh	metam-sodium
Vorlex (2)	ifnh	1,3-dichloropropene and other related chlorinated C_3 hydrocarbons/methyl isothiocyanate
Vorlex CP (2)	ifnh	1,3-dichloropropene and other related chlorinated C_3 hydrocarbons/methyl isothiocyanate/chloropicrin
Vorlex Plus (2)	ifnh	1,3-dichloropropene and other related chlorinated C_3 hydrocarbons/methyl isothiocyanate
Vorlex Plus CP (2)	ifnh	1,3-dichloropropene and other related chlorinated C_3 hydrocarbons/methyl isothiocyanate/chloropicrin

**The numbers within the brackets () identify the Schedules in which the BRAND NAME products listed in this Table are classified under the Pesticides Act.*

Explanation of Schedules

Schedule 1 Restricted. Use Permit only.
Schedule 2 Restricted to agriculturalists, licensed exterminators and registered custom sprayers.
Schedule 3 May be available for "Domestic" purposes if so registered.
Schedule 4 "Domestic" products only.
Schedule 5 Limited to application on agricultural land.
Schedule 6 Similar to Schedule 4 but may be registered for agricultural/commercial use.

For further information on the regulatory aspects of the classification please contact the Ministry of the Environment office nearest you. (see page 32).

FERTILIZATION AND SOIL MANAGEMENT

Proper fertilization plays an essential part in maintaining maximum yields of high quality tobacco. The analyses of fertilizer and rates of application vary with the type of tobacco and the soil upon which it is grown. Effective use of fertilizers is related to soil fertility and management, soil organic matter, manure application, soil reaction, cultural methods, incidence of disease, and variety of tobacco. Commercial fertilizers supplement and balance the plant food in the soil. Suitable crop rotations and cover crops supply organic matter that reduces leaching of plant nutrients and lessens soil erosion.

The Fertilizers Act

This is an Act for the regulation and control of Agricultural Fertilizers which is administered by the Plant Products Division of Agriculture Canada.

According to regulations under the Fertilizers Act, each fertilizer to which micronutrients have been intentionally added must have a label guarantee showing the amount of each micronutrient expressed in percent on an elemental basis.

Standards for Tobacco Fertilizers

There are special standards recommended for the forms of nitrogen and the amounts of magnesium and chlorine that should be present in tobacco fertilizers.

Nitrogen At least one-quarter of the total nitrogen should be in the nitrate form except for side-dressing fertilizer, in which at least one-half of the nitrogen should be in the nitrate form.

Chlorine The level of chlorine must be controlled within narrow limits because of its effect on seedling growth and burn and moisture holding capacity of the cured leaf. A high level of chlorine in the cured leaf lowers the burning quality and causes excess moisture uptake by the leaf. Excess chlorine in the seedbed may be toxic to young seedlings and may also contribute to damage from soluble salts.

Seedbed It is recommended that the special tobacco seedbed fertilizer, 4-30-8, contain no more than 1.25% chlorine.

Flue-cured The amount of chlorine is regulared as follows: (a) a fertilizer containing less than 2% nitrogen should have a maximum chlorine content of 3% and a minimum of 0; or (b) a fertilizer containing 2% or more nitrogen shall have a minimum chlorine content equal to the guaranteed nitrogen content and the maximum chlorine content shall not exceed the minimum by more than one percent. For example, a 3-9-18 analysis should contain a minimum of 3% and a maximum of 4% chlorine.

Burley No more than 1.25% chlorine is allowed in the fertilizer.

MAGNESIUM

Seedbed The special tobacco seedbed fertilizer, 4-30-8, should contain a minimum of 2% water soluble magnesium.

Flue-cured Flue-cured tobacco fertilizers, except for the seedbed fertilizer, should contain a level of water soluble magnesium that is equivalent to 40% of the guaranteed nitrogen content of the fertilizer. For example, a 3-9-18 analysis should contain 1.2% water soluble magnesium.

Burley Burley tobacco fertilizers should contain 0.6% water soluble magnesium (Mg).

FERTILIZER ANALYSES

The following analyses (Table 5) are recommended by the Ontario Soil Management Research Committee.

SEEDBED FERTILIZATION

The following general recommendations are for all types of tobacco grown on muck in conventional seedbeds.

Information on fertilizing seedlings produced by other methods may be obtained at the Agriculture Canada Research Station, Delhi and in Ontario Ministry of Agriculture & Food Factsheet *Culture of Tobacco Seedlings in Todd Cells,* Agdex No. 181.

NOTE Avoid the use of growth media containing composted sewage sludge.

TABLE 5. RECOMMENDED ANALYSES

FLUE-CURED

Planting and Early Side-dressing Fertilizers

3-6-18
3-9-18 or 4-12-24
3-12-18
2-10-16 or 3-15-24
5-10-30

Late Side-dressing Fertilizers

3-6-18
9-0-27

Seedbed Fertilizer

4-30-8

BURLEY

Field Fertilizers

3-18-18
5-10-15 or 7-14-21

Seedbed Fertilizer

4-30-8

Soil Testing Nutrient levels, pH and total salts in the seedbed can be determined by having samples of the seedbed soil tested at the Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario N1H 6T9. To determine whether any variation from the general fertilizer recommendation before seeding is required, samples should be taken in the fall after any new muck has been incorporated. Samples may also be taken in April for guidance regarding fertilization during May.

Fertilization Before Seeding Apply 25 kg of 4-30-8 special tobacco seedbed fertilizer/100 m^2 of seedbed area.

Fertilizer may be applied before or after steaming. Spread the fertilizer uniformly and thoroughly mix with the top 4 cm of seedbed.

Caution High rates, shallow incorporation and uneven distribution of fertilizer may cause a problem with soluble salts resulting in thin stands and patchy growth.

Fertilization During May If tests or observations indicate the need, apply liquid, soluble powder or granular fertilizer at least two weeks before planting, at a rate that will supply 0.25 kg of nitrogen (N) per 100 m^2 of seedbed area. For example, a soluble complete fertilizer containing 15% nitrogen would be applied at the rate of 1.7 kg dissolved in at least 200 L of water/100 m^2. Wash the solution off the plants immediately after application, otherwise burning may occur.

If plant growth is slow and leaves are pale green this treatment may be repeated.

NOTE

1. Nitrogen deficiency often occurs, during early May, in seedbeds that were chemically sterilized. The feeding program recommended under "Fertilization During May" should begin in the first week of May in these seedbeds.

2. Potash deficiency occasionally develops in seedbeds composed of a high proportion of new muck and fertilized with the normal rate of 4-30-8. A whitish-yellow mottling of the interveinal tissue of the older leaves is a sign of potash deficiency. Although the lack of potash is seldom severe enough to affect growth it is adviseable, in this situation, to fertilize during May with a complete fertilizer rather than one that supplies only nitrogen.

Soluble Salts

High levels of soluble salts often accumulate in the seedbed, causing reduced and/or delayed germination, tipping-over, stunting and root damage. Fertilizer is generally the main source of salts although in some areas the water from deep wells may be very high in salts.

(a) Preventing Salt Problems

Do not apply more than the recommended amount of fertilizer before seeding.

Complete removal of the old muck and replacement with new muck each year is recommended in those greenhouses where drainage is not good and in any greenhouses where salt problems have been experienced.

Leaching of the seedbed during the fall and before spreading new muck, is recommended as a means of avoiding salt problems. For effective and uniform leaching the following procedure is suggested.

Step 1 Thoroughly moisten the seedbed with a sprinkler, to the depth of soil moisture or at least 30 cm. This is easily done in June but, later in the summer or fall, several days may be required to have the seedbed uniformly moistened.

Step 2 Apply at least 10,000 L of water/100 m^2 of seedbed area. This may be done by flooding or with a sprinkler.

Step 3 After 3 or 4 days repeat step number 2.

NOTE Thorough moistening before flooding is essential. Flooding a dry seedbed results in uneven water penetration which accomplishes salt removal in some areas but not in others.

(b) Correcting Salt Problems

During the greenhouse season salt problems usually occur in areas of the seedbed that dry most rapidly (loose areas or areas receiving less water).

This problem can be corrected by leaching. In fact, if the problem is detected early enough, corrective measures can produce a normal stand of plants. Samples of muck, from the seedbed, may be tested at the Research Station to determine the level of soluble salts.

To obtain effective leaching, first moisten the seedbed and then apply at least 2,500 L of water/100 m^2 of seedbed area. If, after testing a sample, the salts are still high, repeat the leaching procedure.

FIELD FERTILIZATION

Fertilizer requirements for tobacco should be determined by using a soil test along with information on soil type, past management and yield and quality of tobacco usually produced on the field.

Nitrogen, phosphate and potash are the main nutrients to be considered in a fertilizer program. To provide dependable recommendations fields should be tested before each tobacco crop.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper not provided through the OMAF services. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations leads to less reliable recommendations than are now provided.

Phosphate and Potash Phosphate and potash requirements for flue-cured and burley tobaccos are presented in the following table. This table should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the Agri-Food Laboratories. After deciding on the amount of nitrogen you wish to apply choose an analysis of fertilizer that most closely fits the phosphate and potash requirements as indicated by your soil test.

NOTE Where there is a requirement of more than 180 kg of phosphate and 220 kg of potash it is considered best to apply the additional amounts as a separate application rather than in bands at planting time.

TABLE 6. PHOSPHATE AND POTASH REQUIREMENTS FOR TOBACCO BASED ON OMAF SOIL TESTS

Phosphorus Soil Test (PPM)	Rating	Phosphate (P_2O_5) Required-kg/ha	Potassium Soil Test (PPM)	Rating	Potash (K_2O) Required-kg/ha
0 - 3		260	0 - 15		270
4 - 5		250	15 - 30		260
6 - 7	Low	240	31 - 45	Low	240
8 - 9		230	46 - 60		220
10 - 12		220	61 - 80		190
13 - 15		210	81 - 100		170
16 - 20		200	101 - 200		150
21 - 25		180	121 - 150		140
26 - 30	Medium	160	151 - 180	Medium	130
31 - 40		140	181 - 210		120
41 - 50		110			
			211 - 250	High	110
51 - 60	High	80			
61 - 80		50	250+	Very High	100
80+	Very high	20			

TABLE 7. ANALYSES AVAILABLE THROUGH THE OMAF SOIL TESTING SERVICE, AT AGRI-FOOD LABORATORIES, 503 IMPERIAL ROAD, UNIT ONE, GUELPH, ONTARIO N1H 6T9

MATERIALS	WHAT IS ANALYZED	COST PER SAMPLE*
(1) Field Soils	Plant-available Phosphorus; Potassium, Magnesium; pH; Lime requirement; Calcium (On tobacco soils only)	No Charge
(2) Home Garden and Lawn Soils	Plant-available Phosphorus; Potassium, Magnesium; pH; Lime requirement	$1
(3) Commercial Turf Soils	Plant-available Phosphorus, Potassium, Magnesium; pH; Lime requirement	No Charge
(4) Greenhouse Media, Water** and Nutrient Solutions**	Plant-available Nitrogen, Phosphorus, Potassium, Calcium, Magnesium; pH; Sulphates; Chlorides; Total Salts	No Charge
(5) All Soils (optional, on request only)	Plant-available Manganese and Zinc	$2
(6) All Soils (optional, on request only)	Organic Matter	$5

* *Prices effective September 1, 1985*
** *Laboratory requires 500 mL sample.*

FLUE-CURED TOBACCO FERTILIZATION

Nitrogen Under Ontario conditions there is no reliable test for nitrogen. In addition the amount of nitrogen available from organic matter will vary from season to season depending largely on rainfall and temperature. For these reasons it is extremly difficult to determine the optimum amount to apply.

Usually previous tobacco crops provide the most reliable basis for determining the nitrogen requirement. A record of each field should be kept over the years to have an accurate picture of maturity, size, quality and yield for more than one tobacco crop year. The amount of nitrogen applied to previous tobacco crops may be used as a base from which to determine nitrogen requirements within a certain range.

A range of 16 to 36 kg/ha of nitrogen will cover practically all situations from sandy loam to sandy soils. Using the rate applied to previous crops as a base you can make adjustments within the indicated range depending on your judgement of the nitrogen-supplying power of the soil. It is generally considered that an adjustment of at least 4 kg/ha of nitrogen would be required to make any significant change in the crop. Also adjustments in the direct fertilizer application of nitrogen may help but cannot be expected to completely correct a problem of too much or too little nitrogen in the soil. The use of nitrogen on the previous rye or wheat crop and the application of manure are just as important as the amount of nitrogen directly applied to the crop.

TABLE 8. GENERAL NITROGEN RECOMMENDATIONS

	Kg/ha Nitrogen	Examples kg/ha
Sand	30 - 36	1000 to 1200 kg of a 3% nitrogen fertilizer such as 3-9-18 or 750 to 900 kg of a 4% nitrogen fertilizer such as 4-12-24 or 600 to 720 kg of a 5% nitrogen fertilizer such as 5-10-30
Loamy Sand	24 - 27	800 to 900 kg of a 3% nitrogen fertilizer such as 3-12-18 or 3-9-18
Sandy Loam	16 - 20	800 to 1000 kg of a 2% nitrogen fertilizer such as 2-10-16

Magnesium Magnesium is usually supplied in sufficient quantities in the complete fertilizer to prevent magnesium deficiency commonly called "sand drown".

A soil test is needed to identify the few cases where extra magnesium is required. When the soil test value for magnesium falls below 30, a side-dress application of 150 - 200 kg/ha of Sul-Po-Mag or K-Mag is recommended. This extra application is also recommended with magnesium soil test values of 30 to 40 when the ratio of calcium to magnesium is 40 or more. For example, soil test values of 1500 for calcium and 36 for magnesium (ratio of 42) indicate the need for extra magnesium.

Side-dressing Excess rainfall, during the first 4 to 5 weeks after planting, may cause considerable leaching of certain nutrients, particulary nitrogen, and to a lesser extent, potash, magnesium and chlorine. Rainfall of 25mm or more during a 24-hour period is sufficient to cause leaching when the soil is moist prior to the rain.

Side-dressing, to replace nutrients lost through leaching, should be done soon after (within 4 to 5 days) the leaching has occurred. A low phosphate tobacco fertilizer of the type used at planting is preferred for any application up to late June (about June 25). The special side-dressing fertilizers are suited mainly to application during the last few days in June and in early July.

The required amount of side-dressing will vary according to several factors including amount of rainfall, amount of fertilizer applied at planting, soil texture, drainage and fertility. As a general guide the following amounts of nitrogen are suggested when side-dressing is required:

TABLE 9. GENERAL SIDE-DRESSING RECOMMENDATIONS

	kg/ha Nitrogen	Examples kg/ha
Sand	9 to 11	3-6-18 at 300 to 375 kg or 9-0-27 at 100 to 125 kg
Loamy Sand	7 to 9	3-6-18 at 225 to 300 kg or 9-0-27 at 80 to 100 kg
Sandy Loam	5 to 7	3-6-18 at 165 to 225 kg or 9-0-27 at 55 to 80 kg

Burley Tobacco Fertilization

Sandy loam and gravelly loam soils produce the best quality burley. Clay loam soils tend to produce tobacco too high in chlorine and too low in potassium content, two factors that contribute to poor burning quality. The production of burley with good quality is of utmost importance if the domestic and export markets are to be maintained and expanded.

Nitrogen Under Ontario conditions there is no reliable test for nitrogen. The decision on the amount of nitrogen required should be based on past fertilization, cropping history and the performance of previous burley crops.

The following table serves as a guide for inexperienced growers or growers who may want to change their fertilization management in order to adapt to the heavier and darker quality burley that is now required by the industry.

TABLE 10.

	kg/ha Nitrogen
1. Sands to Loamy Sands (light texture)	220
2. Sandy or Gravelly Loams (medium texture)	200
3. Sandy Loams to Loams (heavy texture)	170

Manure

Manure can be used as a source of plant food and organic matter. The content of N, P_2O_5 and K_2O in manure is extremely variable. Chemical analysis will indicate more accurately, than the following table, the amounts of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. Your local agricultural office can provide further information on the testing of manure.

NOTE Fertilizer formulations containing muriate of potash (potassium chloride) should not be used on burley tobacco because of the high chlorine level which lowers the burning quality of the leaf.

TABLE 11. AVERAGE PLANT FOOD AVAILABLE FROM MANURE IN FIRST CROP YEAR

Source	Tonnes/ha	kg/ha N	P_2O_5	K_2O
Cattle	12	36	12	53
Swine	12	46	24	31
Poultry	5	88	38	48

FLUE-CURED TOBACCO

Manure is not required on many farms where nitrogen is used during the spring and summer on the rye or wheat crop. However, sandy tobacco soils, particularly sandy knolls, usually benefit from an application of 12 to 18 tonnes/ha of cattle or swine manure. As the table indicates, poultry manure is high in nitrogen and is generally not recommended.

The use of manure on soils high in fertility is likely to delay maturity and to lower quality.

BURLEY TOBACCO

If manure is to be used, it should be applied at least a year before the burley crop. This allows for adequate decomposition of the organic matter and the disappearance of chlorine. Manure applied too close to tobacco delays maturity, increases the chlorine content, and lowers burning quality of the leaf.

Rotations

FLUE-CURED TOBACCO

In a two-year rotation with tobacco, rye has generally proven to be better than wheat in maintaining or increasing the amount of organic matter in the soil. Wheat is more subject to winter kill and factors such as fall seeding date, nutrient shortage and pH are much more critical with wheat as compared to rye. For example, wheat can be seriously affected in certain fields by a shortage of manganese while in the same fields tobacco and rye grow normally. Wheat may be substituted for rye where fertility is high, especially on soils with a sandy loam texture. Wheat is unlikely to produce sufficient crop residue on medium to course-textured tobacco soils.

TABLE 12. FERTILIZATION OF RYE

	Nitrogen (kg/ha)	Examples (kg/ha)
(a) Early spring when growth starts		
1. Sand	45	Ammonium nitrate (33-34% N) at 135 kg or Urea (45-46% N) at 100 kg.
2. Loamy Sand	35	Ammonium nitrate at 105 kg or Urea at 80 kg.
3. Sandy Loam	25	Ammonium nitrate at 75 kg or Urea at 55 kg.

NOTE Nitrogen should not be used in the spring in fields where tobacco is oversized and matures late or in loamy sand to sandy loam soils where the field has been out of tobacco for more than one year.

(b) Summer - To crop residues	25 - 30	Ammonium nitrate at 75-90 kg/ha or Urea at 60-65 kg/ha.

NOTE
1. Less than 25 kg of N should be applied in the summer to sandy loam soils where slow maturity has been experienced in the tobacco crop.
2. Maturity of tobacco may be delayed if nitrogen is applied after mid-August or at a high rate.

FERTILIZATION OF WHEAT

Wheat should generally be fertilized in the spring with double the nitrogen rates recommended for rye in the previous table. Rates should be reduced by one-half in fields where tobacco is oversized and matures late or in medium to heavy soils where the field has been out of tobacco for more than one year.

For crop residues apply the same rate of nitrogen as indicated for rye and according to the precautions in notes 1. and 2.

BURLEY TOBACCO

Burley should not follow crops where high rates of muriate of potash have been used because of the danger of increasing the chlorine level and lowering the burning quality of the leaf.

Burley is usually grown in rotation with other crops. Crop rotation is important to minimize virus diseases, to reduce the buildup of black root rot disease, and to maintain good soil structure and composition.

The crop grown before burley is important in the rotation. Winter wheat and a winter cover crop of fall rye are two of the best. Tomato and tobacco are very closely associated and have similar diseases. They should not follow one another closely in a rotation. There is a risk with a legume crop such as alfalfa or clover, before burley, unless plowed in the fall. Spring plowing of leguminous crops usually results in later maturity and a darker or lower quality leaf.

Continuous cropping of burley tobacco on the same soil can improve leaf quality but black root rot disease is more common under conditions of continuous culture, particularly under cool, wet conditions in the spring. Stands may become spotty or drastically reduced. Soil structure can also be impaired under a burley monoculture unless a winter cover crop of fall rye is incorporated into the sequence.

Soil Testing (Field)

Fall is the best time to take soil samples for tobacco. Soil sample boxes and questionnaire forms may be obtained from your nearest Research Station, College of Agricultural Technology, Agricultural office, or from Agri-Food Laboratories, Unit 1, 503 Imperial Road, Guelph, Ontario, N1H 6T9. Proper sampling procedure is outlined on the questionnaire.

Tissue Testing

A service for the chemical analysis of plants and other organic materials such as sludge and manure is available at the Department of Land Resource Science, University of Guelph. This service is available on a charge per sample basis. For more information inquire at your local Agricultural office or Research Station.

Micronutrients

Additions of the micronutrients boron, copper, iron, manganese, molybdenum and zinc are generally not required for tobacco in Ontario. Surveys of tobacco soil and leaf tissue show that levels are usually adequate and, in some cases, excessive. For example, very high levels of iron, manganese and zinc are occasionally found in the cured leaf and these are associated with a certain type of "grey" tobacco.

Testing for Micronutrients Before applying any micronutrient it is important to establish the need since the range between beneficial and harmful amounts is very narrow. A tissue test for boron, copper, manganese and zinc is available on a charge per sample basis. Contact your local agricultural office for further information.

Manganese and zinc soil tests are provided by the OMAF service (see page 17). To prevent contamination of soil samples, especially with zinc, do not use galvanized (zinc plated) soil sampling tubes or metal containers to collect and mix samples. Plastic containers in good condition should be satisfactory. Soil samples that have contacted galvanized surfaces are unsatisfactory for zinc soil tests.

Problem areas should be sampled separately because micronutrient deficiences frequently occur in small areas of the field. Soil or plant samples taken from the entire field are unlikely to provide identification of the problem.

Manganese Soil Test Interpretation*

Manganese Soil Test	Suggested Treatments
Over 30	Soil manganese availability is adequate for field grown crops.
16 to 30	Soil manganese availability is adequate for many crops but is approaching deficiency levels for oats, barley, wheat and soybeans. Manganese may be deficient for acid requiring crops such as blueberries. If deficiency symptoms appear spray with manganese. You may wish to re-check for deficiency using plant analysis.
below 16	Soil manganese availability is believed to be insufficient for oats, barley, wheat and soybeans. Spray with manganese at the four leaf stage and again three weeks later if required. Manganese deficiency has not been diagnosed on commercial corn hybrids or on tobacco in Ontario even on soils which are very deficient for wheat. The manganese soil test has not been evaluated for vegetables. Until more information is available manganese deficiency should be suspected on onions, lettuce and red beets.

**Manganese availability is markedly affected by soil acidity (pH). The manganese soil test which is reported has been adjusted for soil pH as follows: Manganese soil test reported = 498 + 0.248 (phosporic acid extractable soil manganese) − 137 pH + 9.64 pH^2.*

Preventing and Correcting Manganese Deficiency Manganese is less available at high soil pH so it is important not to add more lime than is needed to correct soil acidity.

Manganese deficiency should be corrected at an early stage of crop growth by spraying with 2 kg manganese/ha as manganese sulfate, or 0.4 kg manganese/ha in chelated form, in 200 L of water. Use of a "Spreader Sticker" is recommended. If the deficiency is severe a second spray may be beneficial.

Soil application of manganese is not recommended because of the large amounts required.

Zinc Soil Test Interpretation*

Zinc Soil Test	Suggested Treatments
Over 200	You should suspect contamination of the sample or of the field.
25 to 200	Soil zinc availability is adequate for most field grown crops.
15 to 25**	Zinc availability is adequate for most field crops except corn. Zinc availability is bordering on deficiency for corn. If the field sampled is uneven in soil texture, pH, or erosion, some areas may respond to zinc applications. Deficiency symptoms at the 4 to 6 leaf stage are a reliable indication of zinc deficiency (see OMAF Factsheet 100/531). Most crops except corn are unlikely to suffer from zinc deficiency.
less than 15**	Zinc is likely to be deficient for corn and should be applied in the fertilizer. The zinc soil test has not been evaluated for vegetables. Until more information is available deficiency should be suspected on onions. Zinc deficiency has not been diagnosed on tobacco in Ontario.

**Zinc availability is affected by acidity (pH). The zinc soil test reported has therefore been adjusted for soil pH as follows: Zinc soil test reported = 203 + 4.5 DTPA extractable soil zinc − 50.7 soil pH + 3.33 (soil pH^2).*

***Soil test values as reported and deficiency levels were changed in September 1984. Values and deficiency levels before September 1984 are therefore different than those after that date.*

Preventing and Correcting Zinc Deficiency High phosphorus in the soil and/or in the fertilizer can cause or increase the severity of zinc deficiency. Apply only the recommended amount of phosphorus. Use of animal manures can prevent or reduce zinc deficiency. Erosion control can prevent deficiency of zinc by maintaining the topsoil.

Zinc deficiency can be prevented by application of zinc fertilizer to the soil. Foliar sprays can be useful to correct a deficiency after the symptoms have appeared provided this is done early in the growing season.

Where zinc is required 4 to 14 kg zinc/ha should be applied as zinc sulfate or zinc oxide in the fertilizer. The higher rate should last for up to 3 years. Not more than 4 kg zinc/ha should be banded at planting. Zinc chelates can be used to supply 1 to 2 kg zinc/ha but the greater efficiency of this source should not be expected to last more than one year.

For foliar application zinc sulfate may be used at rates supplying 60 g zinc/100 litres (0.6 lb./100 gal.). Zinc chelate may be used at 1/5 the rate for zinc sulfate. A wetting agent should be added and spraying should be done when plants are not wilted. Spray as soon as zinc deficiency symptoms appear. In severe cases it may be necessary to spray a second time 3 weeks later.

OTHER MICRONUTRIENTS

Copper soil tests are quite unreliable on Ontario soils but plant analysis is useful. Copper is unlikely to be deficient on mineral soil except perhaps on very sandy soils. Copper deficiency does occur on organic soils and is best diagnosed by plant analysis. When organic soils are first brought into cultivation copper should be applied to the soil at 8 kg, copper/ha for each of the first three years.

Boron is routinely applied for rutabagas in Ontario and on some soils it is required for alfalfa and several vegetable crops. Boron deficiency usually occurs in dry weather so that response is erratic and for this reason we have not been able to develop a reliable soil test. Plant analysis is useful as a predicter of boron requirements as are visual symptoms on the plants. See also OMAF Factsheet 121/531. Boron is recommended for alfalfa on loam and sandy loam soils from the Niagara Escarpment east to Kingston. It may be required for alfalfa in dry years on sandy loam soils and sands in the remainder of the province.

Boron deficiency has not been diagnosed on cereals, peas and beans in Ontario and boron applications to these crops, or applied to other crops in the year preceding them, can be toxic. Boron should not be banded at seeding.

Iron has not been found to be deficient in field crops in Ontario. It is occasionally deficient on some ornamentals and on blueberries or other acid requiring crops when they are grown on neutral or alkaline soils.

Molybdenum is occasionally deficient on some vegetable crops on acid organic or mineral soils, the most practical solution usually being to add lime as molybdenum is more available at neutral or alkaline pH values. Molybdenum treatment of the seed has been successful for onions on organic soils.

SOIL ACIDITY AND LIMING

The need for limestone is determined by testing the soil to find the reaction (pH). On tobacco soils the most reliable indication of pH is obtained from late fall or early spring sampling. The soil pH for tobacco should be above 5.5. Wheat, which is often grown in rotation with tobacco, is favored by a pH of 6.0 or slightly above.

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most field crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. The accompanying table shows the soil pH values below which lime is recommended and the "target" soil pH to which soils should be limed for different crops. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended. However, in tobacco production excessive use of limestone to raise the pH beyond 6.5 may decrease the availability of certain micronutrients and create favourable conditions for the development of black root rot.

The Buffer pH Different soils with any one soil pH value, say 5.2, will require different amounts of lime to bring the pH to a particular desired level, say 6.0, depending chiefly on the clay and organic matter content of each soil. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime (based on soil pH) the accompanying table may be used to determine the amount of lime required to reach different "target" soil pH values required for different crops.

Soil pH at Which Lime is Recommended for Ontario Crops.

Crops	Soil pH below Which Lime is Recommended	Target Soil pH
Coarse and Medium Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf,tobacco, established tree fruits and grapes.	5.6	6.0
Potatoes	5.1	5.5
Blueberry, cranberry, rhododendron, azalea.	No lime recommended	

Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH.

Buffer pH	Target Soil pH = 6.5 Lime if soil pH below 6.1	Target Soil pH =6.0 Lime if soil pH below 5.6	Target Soil pH = 5.5 Lime if soil pH below 5.1
Ground limestone required—t/ha (Based on an Agricultural Index of 75)			
7.0	2	0	0
6.9	2	0	0
6.8	2	0	0
6.7	2	2	0
6.6	3	2	0
6.5	3	2	0
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	9	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

Limestone Quality Calcitic limestone consists largely of calcium carbonate. Dolomitic limestone is a mixture of calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent inexpensive source of magnesium for acid soils. On soils with magnesium tests greater than 100, either calcitic or dolomitic limestone may be used.

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90.

In general, the higher the calcium and magnesium content of a limestone the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone and, hence, it neutralizes acidity much more slowly; so slowly that it is of little value. The calculation of a fineness rating for ground limestone is illustrated in the accompanying table.

Example Calculation of the Fineness Rating of a Limestone

Particle Size	% of Sample		Effectiveness Factor		
Coarser than no. 10 sieve[1]	10	x	0	=	0
No. 10 to no. 60 sieve	40	x	0.4	=	16
Passing through no. 60 sieve	50	x	1.0	=	50
	Fineness Rating			=	66

[1] *A no. 10 tyler sieve has wires spaced 2.0 mm, and a no. 60 Tyler sieve spaced 0.25 mm apart.*

The Agricultural Index Some means of combining the Neutralizing Value and the fineness Rating is needed to compare various limestones that are available. The index which has been developed in Ontario to do this is called the "Agricultural Index".

$$\text{The Agricultural Index} = \frac{\text{Neutralizing value x fineness rating}}{100}$$

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity. Lime with a high Agricultural Index is worth proportionately more than lime with a low index because it may be applied at a lower rate. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price per tonne of limestone B.

The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.

Recommendations from the Ontario Soil Test Service are based on limestone with an Agricultural Index of 75. If you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\text{Limestone application rate from soil test report} \times \frac{75}{\text{Agri. Index of your limestone}} = \text{application of your limestone}$$

For example if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 9 x 75/90 = 7.5 t/ha.

Tillage Depth Lime recommendations presented here should raise the pH of the top 15 cm (6 inches) of a soil to the listed target pH. If the soil is ploughed to a greater depth than 15 cm, proportionately more lime is required to reach the same target pH. Since lime moves very slowly in soils it should be incorporated to 15 cm depth where practical.

Lowering Soil pH On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate, but this is not advisable for most crops as it only hastens the time when lime will be required. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

Fertilizer Placement

Fertilizer used at transplanting should be applied in bands 10 cm on each side of the row, and level with or slightly below the root crown (8 to 10 cm deep).

Caution Closer placement of fertilizer could result in root injury, and wider placement could delay early growth.

Broadcasting a complete tobacco fertilizer is a wasteful practice, and may be detrimental to yield and quality under high rainfall or excessive irrigation.

Starter or Transplanting Fertilizers

Starter fertilizers are not recommended. These fertilizers in combination with certain insecticides in the planting water may injure newly transplanted plants, causing either death or stunting (see page 7 under **Seed Maggots**).

Foliage Feeding

Although the tobacco plant can absorb certain nutrients through the leaves in small amounts, spraying fertilizer on the leaves is an impractical method of correcting nitrogen, phosphorus, or potassium deficiency. If additional amounts of these nutrients are required after transplanting, a side-dress application is recommended.

Calibration of Tobacco Fertilizer Applicators

A fertilizer applicator should be calibrated periodically to ensure desired rates of fertilizer application. The amount of fertilizer per plant depends on the plant spacing and rate of application as shown in the following table. For example, when applying 1000 kg/ha of fertilizer and using a plant spacing of 61 x 107 cm (24 x 42 inches), 25 kg will fertilize 383 plants.

When calibrating an applicator, first place and level approximately 15 kg of fertilizer in the hopper, mark this level, and then put in 25 kg of fertilizer. Plant the desired number of plants, as shown on the table, and check the level in the hopper. If the fertilizer is above the mark, too little is being applied, and if below the mark, too much is being applied. Do not place the fertilizer in the hopper until immediately before transplanting, to avoid packing, as this will result in poor calibration. This method will give a fairly accurate calibration of the rate of application, but it is also adviseable to check the fertilizer on an acre and field basis.

TABLE 13.

Plant Spacing		Plant Population		Plants per 25 kg (55.1 lb) of fertilizer											
				Fertilizer Rate kg/ha											
				600	700	800	900	1000	1100	1200	1400	1600	1800	2000	2200
cm (centi-metres)	Inches	Hectare	Acre	lb/acre											
				540	630	720	810	900	990	1080	1260	1440	1620	1800	1980
55 x 102	22 x 40	17507	7128	730	625	547	486	438	398	365	313	274	243	219	199
58 x 102	23 x 40	16903	6818	705	604	528	469	423	384	352	302	264	235	211	192
61 x 102	24 x 40	16072	6534	670	574	502	446	402	365	335	287	251	223	201	183
53 x 107	21 x 42	17634	7112	735	630	551	490	441	401	367	315	276	245	220	200
56 x 107	22 x 42	16689	6789	696	596	522	463	417	379	348	298	261	232	209	190
58 x 107	23 x 42	16113	6493	672	575	504	447	403	366	336	288	252	224	201	183
61 x 107	24 x 42	15321	6223	639	547	479	425	383	348	319	274	239	213	192	174
66 x 107	26 x 42	14160	5744	590	506	443	393	354	322	295	253	221	197	177	161
51 x 117	20 x 46	16759	6818	699	599	524	465	419	381	349	299	262	233	209	190
56 x 117	22 x 46	15263	6198	636	545	477	424	382	347	318	273	239	212	191	173
51 x 122	20 x 48	16072	6534	670	574	502	446	402	365	335	287	251	223	201	183
41 x 102	16 x 40	23912	9801	-	-	-	-	-	-	-	427	374	332	299	272
46 x 102	18 x 40	21313	8712	-	-	-	-	-	-	-	381	333	296	266	242
41 x 107	16 x 42	22795	9334	-	-	-	-	-	-	-	408	357	317	285	259
46 x 107	18 x 42	20317	8297	-	-	-	-	-	-	-	363	317	282	254	231

FLUE-CURED TOBACCO

Varieties of flue-cured tobacco recommended for use in Ontario are: Delgold, Delhi 76, Newdel, Nordel, Virginia 115 and Candel. In recent years, breeding for increased alkaloid content has been emphasized. The newer recommended varieties Delgold, Newdel, Nordel and Candel reflect improvements in this area.

The following variety descriptions are from comparisons made at the Research Station, Delhi, where all have received the same treatment.

DELGOLD was developed at the Research Station, Delhi, from crosses involving Nicotiana rustica, Hicks Broadleaf, and Virginia 115. The plant is light green in color and is fast growing in the greenhouse and in the field. It has intermediate to high tolerance to black root rot and to weather fleck. Delgold is tall and is cylindrical in shape. The leaf has good width, is longer than Virginia 115 but is narrower in the butt section. Ground sucker growth is quite low. Toughness of the leaf at harvest time compares favorably with Virginia 115. The variety is high yeilding and cures easily. In the cured leaf, shades of light orange will predominate throughout the mid-stalk leaves while the upper leaves will range from a light orange to orange color.

DELHI 76 was developed at the Research Station, Delhi from treatment of Delhi 34 seed with Gamma rays to induce mutations. The plant is medium green in color and fast growing in the greenhouse and in the field. It is tall with leaves equally spaced up the stalk. Ground sucker growth may be a problem on some farms. Delhi 76 has a high tolerance to black root rot and to weather fleck. The yield is high and the leaf cures satisfactorily to an orange color particularly in the upper leaves. The leaf cures easily and has good texture and graininess.

NEWDEL was developed at the Research Station, Delhi from crosses involving Nicotiana rustica, Delhi 34 and Virginia 115. The plant is light green in color, medium tall and tapers slightly toward the top. It is fast growing in the greenhouse and in the field. The leaf has good width and length. Newdel has intermediate tolerance to black root rot and is intermediate to high in tolerance to weather fleck. The variety is intermediate to high in yield and cures easily to a uniform color. In the cured leaf, shades of rich light orange color will predominate.

NORDEL was developed at the Research Station, Delhi from crosses involving Nicotiana rustica, Delhi 34 and Virginia 115. Nordel is light green in color and is fast growing in the greenhouse and in the field. It has intermediate to high tolerance to black root rot and intermediate tolerance to weather fleck. The plant style is somewhat similar to Virginia 115 but the plant is a little taller and the top elongates more like Delhi 76. Ground sucker growth has not been a problem but may be more than that of Virginia 115. The yield is intermediate and the cured leaf tends to be a light orange to orange color.

VIRGINIA 115 was developed in the U.S.A. from a cross between Hicks Broadleaf and Coker 139. Virginia 115 is a short-stalked plant with closely spaced leaves. Early seedling growth may be slow, with heart leaves yellowish and slightly deformed. However, the variety will outgrow these characteristics and produce vigorous seedlings by

TABLE 14. FLUE-CURED VARIETY PERFORMANCE (4-Year Average 1981, 1983 - 1985)

Variety	Yield kg/ha	Grade[1] $/kg	Number of Leaves	Days to Topping	Topping Height cm	Ground Suckers kg/ha
Delhi 76	3054	3.68	16.8	62.8	95.7	67.6
Delgold	3134	3.62	18.3	62.2	90.5	10.5
Newdel	2909	3.60	18.0	61.0	86.7	17.9
Virginia 115	2877	3.49	17.7	61.5	82.1	17.8
Candel	3040	3.63	17.3	60.2	83.0	9.4
[5]Nordel	2762	3.52	17.1	59.2	83.1	22.4

Variety	Black Root[2] Rot Rating	Weather[3] Fleck	Company[4] Rating	Total[4] Alkaloids %	Reducing[4] Sugars %
Delhi 76	119	1.6	74	2.45	22.73
Delgold	106	1.7	71	2.65	22.50
Newdel	96	1.9	66	2.81	21.07
Virginia 115	100	1.8	67	2.39	21.47
Candel	89	2.5	74	2.39	23.00
[5]Nordel	110	1.9	74	2.99	19.60

[1]1984 & 1985 grade prices based on $3.76/kg average
[2]Higher number more tolerance
[3]Lower number more tolerance
[4]Three-year average based on 1981, 1983, 1984
[5]Two-year average based on 1981, 1985

transplanting time. Virginia 115 is intermediate in tolerance to black root rot and intermediate to high in tolerance to weather fleck. The tip leaves require adequate moisture to fill out properly and the lower leaves may be affected by leaf drop. The sand leaves are often primed before topping. The tip leaves are slightly narrow and distinctly crinkled. Virginia 115 is intermediate to high in yield. The cured leaf tends to have good texture and graininess, but is less uniform in color than Delhi 76. Muddy-faced leaves may appear in the mid-stalk and upper stalk primings.

CANDEL was developed at the Research Station, Delhi from crosses involving Nicotiana rustica, Delhi 34, Hicks Broadleaf and Virginia 115. The plant is dark green in color and fast growing. It has a short stalk and is cylindrical in shape. Candel is intermediate in tolerance to black root rot and weather fleck. Ground sucker growth is quite low. The variety is early flowering and is early maturing. Soon after topping the leaves become crinkled and as the cultivar progresses towards maturity a uniform yellow to yellow-green pebbled color appears on the upper leaves. All leaves have wide shoulders and tip leaves have good length and width. Candel is intermediate to high in yield and cures easily to a uniform color. In the cured leaf shades of rich orange will predominate.

TABLE 15. SUMMARY OF GRADES EXPRESSED AS PERCENT (4-Year Average 1981, 83, 84, 85)

Variety	Sands %	CL %	CF %	BL %	BF %	ND %	CR %	BK %
Delhi 76	10.8	25.9	7.9	9.9	43.1	0.9	1.6	0.1
Delgold	10.1	18.3	11.8	9.2	46.4	1.1	3.1	0.0
Newdel	10.1	19.1	11.4	15.7	37.1	1.3	4.8	0.1
Virginia 115	11.7	18.2	12.0	6.0	47.1	1.0	3.9	0.2
Candel	10.4	19.5	12.0	6.8	49.6	1.0	0.8	0.0
[1]Nordel	9.9	12.8	17.7	5.4	47.8	0.6	5.4	0.0

[1] Two-year average based on 1981, 1985

BURLEY TOBACCO

KENTUCKY 21 x 10 The F1 hybrid is a high yielding variety with high grade quality. Quality of the lower leaves is maintained over a longer period of time so that it can be harvested later than Burley 1 or Harwin. Optimum harvest maturity is approximately 4 weeks after topping. Topping height and leaf number is lower but tip leaves are larger as compared to Burley 1 and Harwin.

HARWIN Yield and grade quality slightly lower than Kentucky 21 x 10. Plants mature about the same time as Kentucky 21 x 10. Topping height is slightly higher and tip leaf area lower than for Kentucky 21 x 10. Lower leaves are larger and tend to maintain their quality longer in the field than Burley 1. Tip leaves are narrow and longer than Burley 1.

BURLEY 1 Lower yield with lighter cured leaves than other varieties. Topping height is higher with closer spacing of leaves on the stalk than other varieties. Tip leaves are not as large as other varieties. Lower leaves tend to mature early with a tendency to dry before harvest.

TABLE 16. BURLEY VARIETY PERFORMANCE (5-Year Average 1977-1981)

	KENTUCKY 21 x 10	HARWIN	BURLEY 1
Yield (kg/ha)	3213	2988	2830
Grade Index (¢/kg)	169.1	167.8	166.7
Number of Leaves	19.3	21.5	22.0
Days to Flower	59	59	57
Topping Height (cm)	92.8	93.2	97.8
Average Area of 3 Tip Leaves[1] (cm^2)	1384	1259	1099
Company Ratings[2]	78	71	61
Total Alkaloids[3] (%)	4.72	4.19	4.66
Black Root Rot	Moderately Tolerant	Moderately Tolerant	Moderately Susceptible
Weather Fleck	Moderately Susceptible	Moderately Susceptible	Moderately Tolerant
Tobacco Etch Virus	Moderately Tolerant	Moderately Tolerant	Susceptible
Tobacco Mosaic Virus	Tolerant	Tolerant	Susceptible

[1] Results from 1980-82
[2] Results are average of 6 companies with higher number more desireable and based on 1980 and 81 ratings.
[3] Results averaged over 1977-79.

Plant Population and Spacing

Flue-cured Tobacco

The most desireable plant population will vary somewhat from farm to farm depending mainly on soil fertility. A suitable population for most farms is within a range of 15321 to 17634 plants/ha (6200 to 7100 plants per acre). Slightly higher yields may be obtained with higher populations but this advantage may be offset by the added costs of handling more leaves. Also as plant population is increased, there is a tendency to produce a thinner leaf which may be more susceptible to weather fleck.

As row width is increased up to 122 cm (48 inches) yield tends to decrease.

Recommended plant spacings for flue-cured tobacco are indicated in the shaded area of the following table:

TABLE 17. PLANT POPULATIONS PER HECTARE AND ACRE

Row Width		Spacing Within The Row							
		cm 41	46	51	53	56	58	61	66
cm	in	in 16	18	20	21	22	23	24	26
102		23,912	21,313	19,223	18,498	17,507	16,903	16,072	14,854
	40	9,801	8,712	7,840	7,468	7,128	6,818	6,534	6,032
107		22,795	20,317	18,325	17,634	16,689	16,113	15,321	14,160
	42	9,334	8,297	7,467	7,112	6,789	6,493	6,223	5,744
112		21,777	19,410	17,507	16,846	15,944	15,394	14,637	13,528
	44	8,910	7,920	7,128	6,788	6,480	6,154	5,940	5,483
117		20,846	18,580	16,759	16,126	15,263	14,736	14,011	12,950
	46	8,523	7,576	6,818	6,494	6,198	5,929	5,682	5,244
122		19,992	17,819	16,072	15,466	14,637	14,132	13,437	12,419
	48	8,168	7,260	6,534	6,229	5,940	5,682	5,445	5,026

Burley Tobacco

Burley tobacco is usually transplanted 41 cm apart in the row and 102 cm apart between rows (about 16 x 40 inches) giving a plant population of 23,912 plants per ha (about 9,800 plants per acre). This plant spacing promotes quality and yield of tobacco without seriously hampering topping, suckering, and harvesting operations

Irrigation

For more information on irrigation refer to the following Ontario Ministry of Agriculture and Food Factsheets: *Tobacco Irrigation With Gun Sprinklers* Agdex No. 181/565, March, 1980 and *Tobacco Irrigation With Travelling Gun Sprinklers* Agdex No. 181/565, November, 1981.

A permit is required for the taking of more than 45,000 L of water in a day from any ground or surface source of water supply, or a combination thereof for the purpose of irrigating. For further information contact your nearest office of Ontario Ministry of the Environment.

Specific information on irrigating tobacco is difficult to provide because of variations in rainfall pattern, soil type, temperature and other factors that affect moisture availability and rates at which plants use water. However, there are general guides that are helpful in making the important decisions, such as when to irrigate and how much water to apply.

Tobacco may be irrigated any time during the day or night. Irrigation is more efficient during the night because less water is lost through evaporation and usually there is very little wind.

When to Irrigate

Stage and development of the crop are two important considerations in determining when to irrigate. A slight shortage of moisture between the time the tobacco crop is established and early July is not considered harmful. From early July until topping time (stage of rapid growth), moisture requirements are more critical. Irrigation during harvest is occasionally necessary to promote development of the tip leaves and hasten the maturity of the crop.

The most commonly used method of determining when to irrigate is careful observation of the crop and soil, combined with past experience and the amount of rainfall. Although this method has been reasonably successful, it may indicate the need for irrigation too late to obtain maximum benefits.

A more accurate method involves the keeping of a day-by-day record of the soil moisture supply. Daily moisture use is calculated according to stage of growth and temperatures. When this is combined with an accurate record of rainfall the soil moisture supply can be established. Information on this method may be obtained at the Research Station, Delhi.

How Much Water To Apply

The objective in irrigation is to saturate the soil to the depth of the main concentration of roots. Therefore the amount of water to apply, when irrigation is necessary, will vary with soil type and time of season.

TABLE 18. WATER mm (MILLIMETRES) TO APPLY WHEN IRRIGATION IS NEEDED

	June		July				August
Soil Texture	1-15	16-30	1-7	8-14	15-21	22-31	1-20
Sand	8	10	18	23	28	33	38
Loamy Sand	10	13	20	25	33	38	46
Sandy Loam	10	15	23	30	38	46	53

Topping

Flue-cured Tobacco

Time and height of topping have a major influence on tobacco quality and yield.

The best time for topping is just after the top has stretched and before any flowers have opened. Topping all plants, or as many as possible, at the same time, encourages uniform maturity.

Although high topping generally produces more yield than lower topping, maturity of the upper leaves is enhanced by topping so that a good sized tip leaf is produced (about 50 cm in length when full grown). The proper height of topping for maximum quality will vary from one farm or field to another and depends mainly on variety, rainfall distribution, fertility, and time of season. Under average conditions present varieties are capable of producing 17 to 18 leaves.

Burley Tobacco

Burley tobacco like other tobacco types is greatly influenced by time and height of topping. Generally high quality and yield is obtained by topping when 50% of the plants are in extended bud to early flower stage of growth and at 18-20 leaves per plant. This medium topping height produces good mature preferred leaf. Also topping all plants at the same time encourages uniform maturity at harvest. Improved maturity is obtained by harvesting 4 weeks after topping.

SEEDLING PRODUCTION

MUCK REQUIREMENT A uniform layer of muck at least 7.5 cm (3 inches) thick is necessary to provide good conditions for seedling growth. Most growers, rather than remove the old muck each year, add a small quantity of new muck.

As a guide in determining the amount required, when purchasing new muck, a 2.5 cm depth on 100 m^2 would require 2.5 m^3 or 1 inch on 1000 sq. ft. would require 3.1 cubic yards.

SEEDING RATES The amount of seed required to achieve a good stand of plants (120 per 930 cm^2 or 120 per sq. ft.) will vary according to management, type of greenhouse and whether vermiculite is used as a covering after seeding.

Generally the seeding rate without vermiculite should range between 28 g to 165 m^2 and 28 g to 220 m^2 (1 oz. to 1800 sq. ft. and 1 oz. to 2400 sq. ft.). Past experience in the particular greenhouse under your own management should be considered in determining the seeding rate. Many growers find that rates in the centre of the range are most safisfactory.

Reduce the seeding rate by 15 to 20% if you plan to use vermiculite as a covering after seeding.

CAUTION Plant stands may be seriously reduced from excess damage to the seed caused by certain pumps and pumping systems used in seeding. Gear, roller, high volume piston, high volume centrifugal pumps and systems that recirculate the seed-water mixture should not be used. Low volume (less than 30 litres per minute) piston or centrifugal pumps are safe provided the seed-water mixture is hand agitated rather than recirculated and the seed is not germinated beyond the stage when white radicles are first visible.

USING VERMICULITE This material applied as a covering after seeding helps to reduce loss of plants from excess heat and/or dryness and tipping-over.

Several grades of vermiculite are available but you should use only the grade specified for tobacco seedbeds. Sufficient vermiculite should be used to cover but not completely hide the muck surface. One 7 kg bag should cover about 20 m^2 of seedbed.

Uniform application is essential since plants may not emerge from areas where there is a deep layer of vermiculite (over 1 cm).

As suggested under **Seeding Rates**, 15 to 20% less seed should be used where you plan to use vermiculite immediately after seeding. Vermiculite may be applied later if plant losses to "tipping-over" are excessive.

HARDENING-OFF Although plants may be hardened through various combinations of moisture stress and greenhouse temperatures, one of the oldest and best methods involves loosening and drying the seedbed. Loosening may be accomplished by forking or mechanical bed looseners.

Normally loosening would be done about 2 weeks before planting. Where a mechanical plant puller is to be used, seedbeds should be loosened about 3 weeks before the start of planting.

STORING FLUE-CURED TOBACCO

The main problems in storing tobacco for any length of time, and especially from one year to the next, are the damage from various molds, and heating. Insects are not likely to be a problem, but preventive measures need to be taken against rats and mice.

Spoilage is caused by excess moisture either in the tobacco from the start of, or taken up during, the storage period. To minimize the risk of spoilage, tobacco should be packed on the dry side (less than 18% moisture). Also some form of protection needs to be provided such as plastic over and under the tobacco to reduce the affect of variations in moisture in the surrounding air. In most cases facilities are not available to completely eliminate the affects of variations in humidity so periodic thorough inspections are essential. Inspections should be most frequent during and after prolonged periods of mild, damp weather in the fall and spring.

Although trashy grades from lower stalk positions are more prone to spoilage, any type of tobacco may be affected under favourable conditions. Tobacco tends to darken in storage and certain grades such as bright and green may actually improve.

The possibility of spoilage will depend not only on the tobacco and its moisture content but also on the location and type of storage facility. Kilns or barns located on well-drained soil where surrounding air movement is not hampered by trees, hills or other buildings, should offer the safest storage. The capability of providing ventilation after periods of high humidity could be beneficial.

Tobacco in most standard kilns is exposed to wide variations in humidity. This may cause excessive darkening. Considerable damage from various molds may also occur on the lower tiers. For these reasons tobacco should be removed from standard kilns and either sorted and baled or piled in the packbarn.

Bulk kilns on cement pads can provide reasonably safe storage conditions for tobacco in racks, bins or bales but certain precautions need to be taken. Spoilage can occur and is most likely in the bottom tier of racks because of damp conditions close to the cement. Insulated pads should provide drier conditions. Frequent inspection is essential to note any increase in moisture and provide drying conditions when necessary. Exhaust vents should be tightly sealed to prevent any intake of rain or snow.

If bales are stored on the floor of bulk kilns a plastic vapor barrier on the floor should be used. As a further precaution, bales could be stored on top of empty racks installed on the bottom tier.

Bales should not be packed tightly and preferably no more than 2 high in storage. Damp conditions near cement floors in the packbarn or bulk kilns can cause spoilage of tobacco nearest the cement. In the packbarn tobacco should be stored on pallets with a plastic vapor barrier between the tobacco and cement. Plastic could be laid on the cement floor with the pallet on top or on the pallet in which case it would be wise to provide some air circulation between the tobacco and plastic by means of boards, sticks or corrugated cardboard. The plastic vapor barrier is a good precaution even in those barns where plastic has been laid under the cement. If bale stackers or other means of storing the tobacco at a considerable distance above the floor are available the pastic vapor barrier would not be needed. Covering the bales or piles with black plastic will provide some protection from variations in humidity and other conditions that may cause a reduction in quality.

GENERAL INFORMATION

REFERENCES FOR FURTHER INFORMATION

Publications available from the Communications Branch, Ontario Ministry of Agriculture and Food, Legislative Buildings, Toronto M7A 1A5:

75 1986 Guide to Chemical Weed Control

Factsheets - Soil Acidity and Liming
Winter Wheat in Ontario
Air Pollution and Horticultural Crops
Blue Mold of Tobacco
Tobacco Irrigation with Gun Sprinklers
Tobacco Irrigation with Travelling Gun Sprinklers
Culture of Tobacco Seedlings in Todd Cells
Energy for Flue-Curing Tobacco
Energy Management with Forced-Air Tobacco Kilns
Energy Management with Bulk Tobacco kilns

Publications available from Information Division, Agriculture Canada, Ottawa:

1641 Tobacco Diseases
1415 Control of Nematodes in Flue-cured Tobacco in Ontario
1312 Curing Flue-cured Tobacco

Publications available from the Ontario Ministry of the Environment, Field Office.

Personnal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs
Aluminum Phosphide for Groundhog Control

CROP INSURANCE

The Government of Ontario, in cooperation with the Federal Government and through the Crop Insurance Commission of Ontario, offers crop insurance protection for tobacco and several other crops. As a result of a Federal Government subsidy of 50% of the premium and with administration costs paid entirely by the Provincial Government, this valuable protection is available to Ontario farmers at less than half the total cost. The premium is also tax-deductible as an operating expense.

Crop insurance offers protection against losses from a broad range of production hazards including hail, frost, flood, drought, wind, excess moisture and/or rainfall, insect damage and disease.

For further information on Crop Insurance for tobacco contact The Crop Insurance Commission of Ontario, Ministry of Agriculture and Food, Legislative Buildings, Toronto, Ontario M7A 1B7 or the area office at the Research Station, Delhi N4B 2W9, telephone (519) 582-3517.

1986 TOBACCO PRODUCTION RECOMMENDATIONS ACKNOWLEDGEMENTS

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Crop Protection Committee
- Ontario Soil Management Research Committee
- Ontario Tobacco Committee

and personnel of

- Plant Industry Branch, Ontario Ministry of Agriculture and Food
- Agriculture Canada
- Ridgetown College of Agricultural Technology
- Ontario Agricultural College, University of Guelph
- Ontario Ministry of the Environment
- Ontario Ministry of Labour
- Health and Welfare Canada

ONTARIO MINISTRY OF THE ENVIRONMENT
PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill and D. Trenholm 150 Ferrand Dr., Suite 700 Don Mills, Ont. M3C 3C3	416-424-3000 (Ext. 204)
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George St. N., Peterborough, Ont. K9J 3G6	705-743-2972
Simcoe, Muskoka	W. Cowie 12 Fairview Rd., Barrie, Ont. L4N 4P3	705-726-1730
West Central Region		
Haldimand, Norfold, Niagara, Hamilton, Wentworth	J. Percy Ontario Government Building, 119 King St. W., Hamilton, Ont. L8N 3Z9	416-521-7640
Dufferin, Wellington, Waterloo Brant	R. Miller Ontario Government Building 119 King St. W., Hamilton, Ont. L8N 3Z9	416-521-7640
Southwestern Region		
Elgin, Middlesex, Oxford	D.C. Morrow and W. Lampman 985 Adelaide St. S., London, Ont. N6E 1V3	519-661-2200
Essex, Kent, Lambton	H.E. Collins P.O. Box 726, 435 Grand Ave. W., Chatham, Ont. N7M 5L1	519-354-2150
Bruce, Grey, Huron, Perth	B.T. Lobb 20 King St., P.O. Box 688 Ontario Ministry of Agriculture & Food Building, Clinton, Ont. N0M 1L0	519-482-3428
Southeastern Region		
Frontenac, Hastings, Lennox and Addington, Prince Edwards, Leeds and Grenville	D.A. Raddon 133 Dalton St., Kingston, Ont. K7L 4X6	613-549-4000
Prescott and Russell, Renfrew, Stormont, Dundas and Glengarry Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204 Ottawa, Ont. K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett Northgate Shopping Centre, 1500 Fisher St., North Bay, Ont. P1B 2H3	705-476-1001
Cochrane, Timiskaming, Algoma	P. McCubbin 199 Larch St., Sudbury, Ont. P3E 5P9	705-675-4501
Northwestern Region		
Kenora, Rainy River, Thunder Bay	G.R. Gammond Ontario Government Building, Thunder Bay "F", Ont. P7E 6E3	807-475-1305
Head Office	Pesticides Control Section 135 St. Clair Ave. W., Suite 100 Toronto, Ont. M4V 1P5	416-965-2401

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Weight—Volume Equivalents (Water)

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Dry-Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

METRIC EQUIVALENTS

Length

inch	=	2.54 cm = 25.4 mm
foot	=	0.30 m
yard	=	0.91 m
mile	=	1.61 km

Area

square foot	=	0.09 m^2
square yard	=	0.84 m^2
acre	=	0.40 ha

Volume (dry)

cubic yard	=	0.76 m^3
bushel	=	36.37 L

Volume (liquid)

fluid ounce (Imp.)	=	28.41 mL
pint (Imp.)	=	0.57 L
gallon (Imp.)	=	4.55 L
gallon (U.S.)	=	3.79 L

Weight

ounce	=	28.35 g
pound	=	453.6 g
ton	=	0.91 tonne

Pressure

pound per square inch = 6.90 K Pa

Temperature

°F = (°C x 9/5) + 32
°C = (°F - 32) x 5/9

Approximate Application Rate Conversions

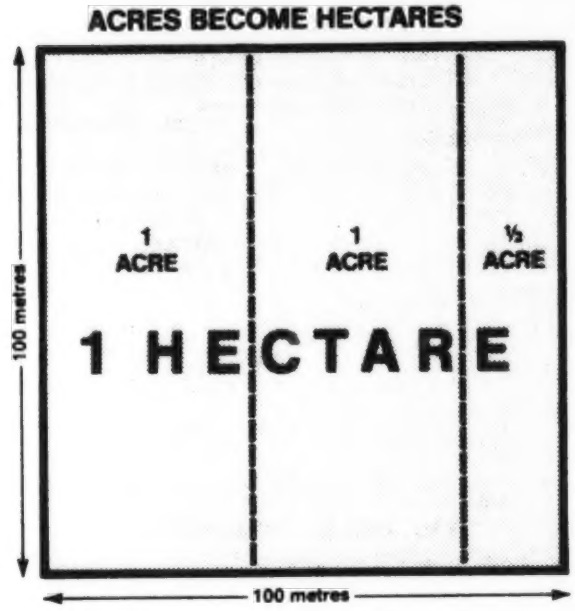
Metric to Imperial

Litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

Imperial to Metric

gallons per acre x 11.23	=	litre per hectare (L/ha)
quarts per acre x 2.8	=	litres per hectare (L/ha)
pints per acre x 1.4	=	litres per hectare (L/ha)
fluid ounces per acre x 70	=	millilitres per hectare (mL/ha)
tons per acre x 2.24	=	tonnes per hectare (t/ha)
pounds per acre x 1.12	=	kilograms per hectare (kg/ha)
ounces per acre x 70	=	grams per hectare (g/ha)

HECTARE-ACRE PERSPECTIVE



HECTARES TO ACRES

1 hectare	=	2.5 acres
2 hectares	=	5.0 acres
3 hectares	=	7.4 acres
4 hectares	=	10.0 acres
5 hectares	=	12.4 acres
6 hectares	=	15.0 acres
7 hectares	=	17.3 acres
8 hectares	=	20.0 acres
9 hectares	=	22.2 acres
10 hectares	=	25.0 acres
20 hectares	=	50.0 acres
30 hectares	=	74.0 acres
40 hectares	=	100.0 acres
50 hectares	=	123.5 acres

ACRES TO HECTARES

1 acre	=	0.4 hectares
2 acres	=	0.8 hectares
3 acres	=	1.2 hectares
4 acres	=	1.6 hectares
5 acres	=	2.0 hectares
6 acres	=	2.4 hectares
7 acres	=	2.8 hectares
8 acres	=	3.2 hectares
9 acres	=	3.6 hectares
10 acres	=	4.0 hectares
20 acres	=	8.0 hectares
30 acres	=	12 hectares
40 acres	=	16 hectares
50 acres	=	20 hectares
60 acres	=	24 hectares
70 acres	=	28 hectares
80 acres	=	32 hectares
90 acres	=	36 hectares
100 acres	=	40 hectares

METRIC APPLICATION RATES WITH AN ACRE PERSPECTIVE

Dry Weight		
10 g/ha	=	4 g/acre
20 g/ha	=	8 g/acre
30 g/ha	=	12 g/acre
40 g/ha	=	16 g/acre
50 g/ha	=	20 g/acre
100 g/ha	=	40 g/acre
500 g/ha	=	200 g/acre
10000 g/ha	=	400 g/acre
1 kg/ha	=	400 g/acre (0.4 kg/acre)
2 kg/ha	=	800 g/acre (0.8 kg/acre)
3 kg/ha	=	1.2 kg/acre
4 kg/ha	=	1.6 kg/acre
5 kg/ha	=	2 kg/acre
10 kgha	=	4 kg/acre
20 kg/ha	=	8 kg/acre
30 kg/ha	=	12 kg/acre
40 kg/ha	=	16 kg/acre
50 kg/ha	=	20 kg/acre
100 kg/ha	=	40 kg/acre
500 kg/ha	=	200 kg/acre
1000 kg/ha	=	400 kg/acre
1 tonne/ha	=	400 kg/acre

Liquid Volume		
10 mL/ha	=	4 mL/acre
20 mL/ha	=	8 mL/acre
30 mL/ha	=	12 mL/acre
40 mL/ha	=	16 mL/acre
50 mL/ha	=	20 mL/acre
100 mL/ha	=	40 mL/acre
500 mL/ha	=	200 mL/acre
1000 mL/ha	=	400 mL/acre
1L/ha	=	400 mL/acre (0.4 L/acre)
2 L/ha	=	800 mL/acre (0.8 L/acre)
3 L/ha	=	1.2 L/acre
4 L/ha	=	1.6 L/acre
5 L/ha	=	2 L/acre
10 L/ha	=	4 L/acre
20 L/ha	=	8 L/acre
30 L/ha	=	12 L/acre
40 L/ha	=	16 L/acre
50 L/ha	=	20 L/acre
100 L/ha	=	40 L/acre
500 L/ha	=	200 L/acre
1000 L/ha	=	400 L/acre

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